JULY, 1958
No. 231

ASTM Bulletin

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American Society for Testing Materials

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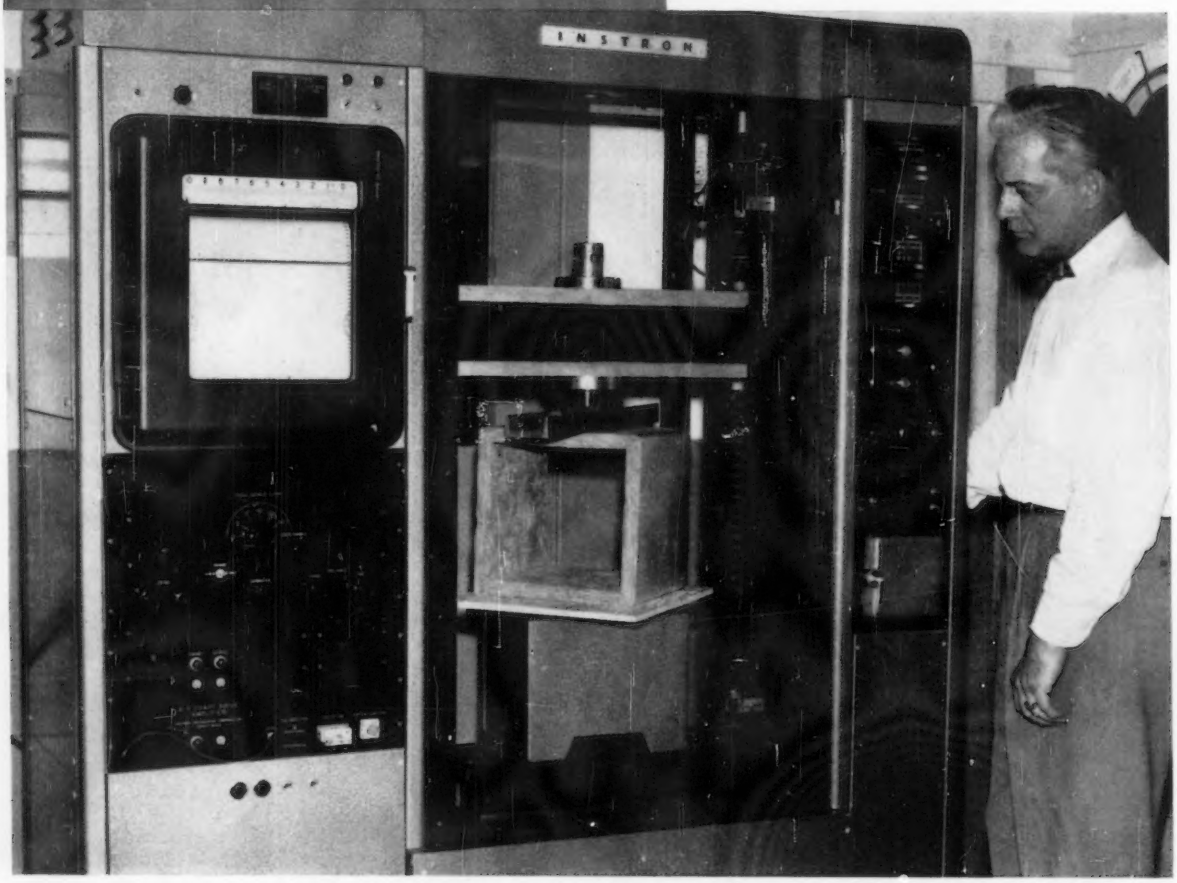

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ASTM BULLETIN

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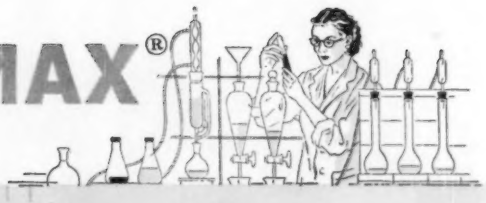

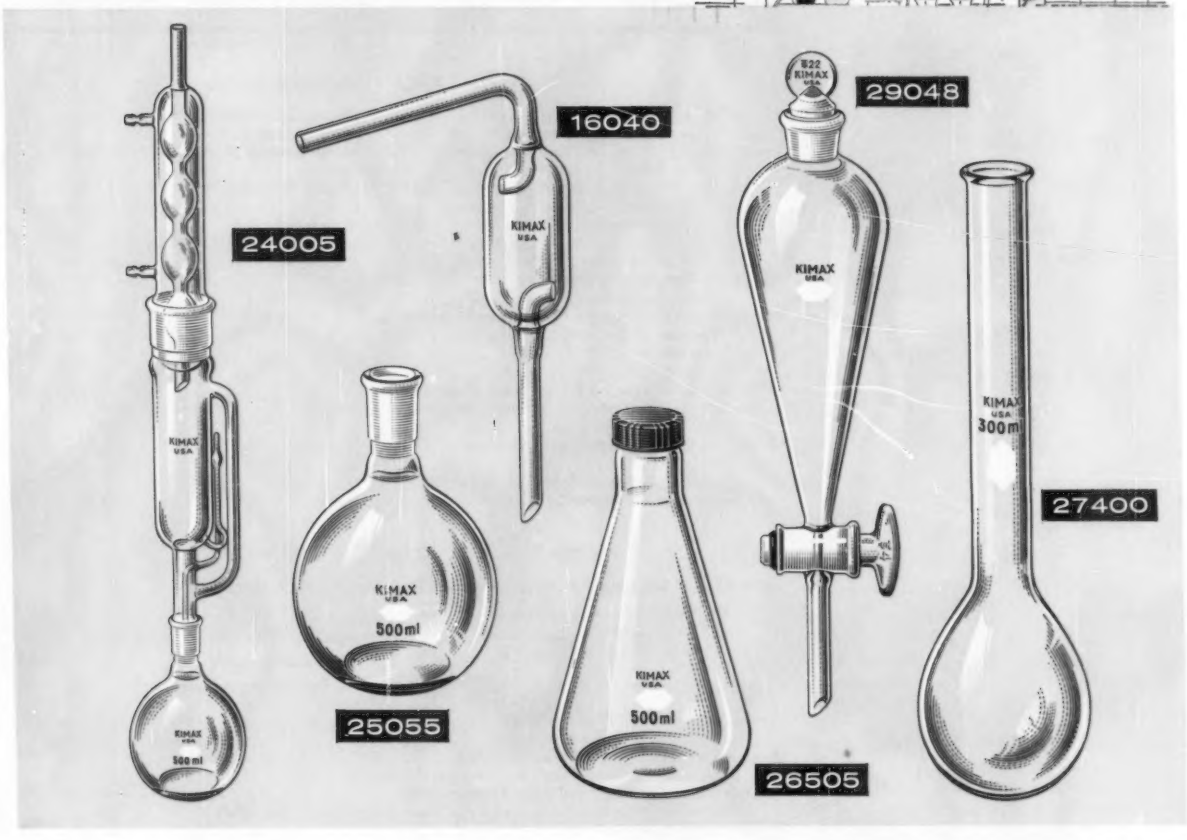

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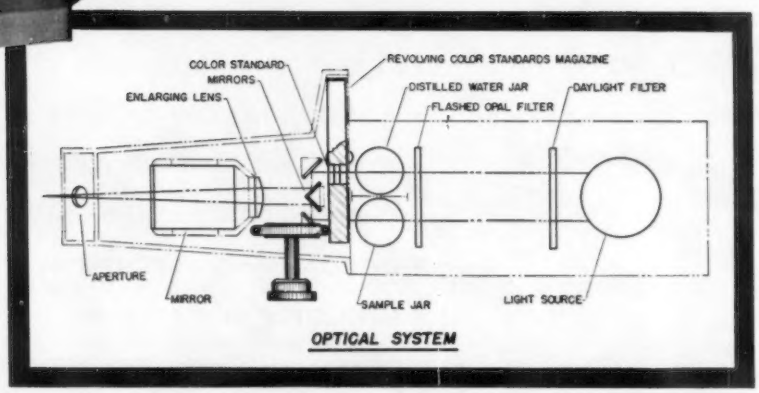

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A Grand Boston "Tea" Party in Retrospect

For one to have a real appreciation of the nature of the recent Annual Meeting, he would need to have been exposed to the really enthusiastic atmosphere that prevailed throughout the week, due in no small measure to the careful planning and cordial reception by the Local Committee on Arrangements. Mere statistics are incidental. It was the largest annual meeting in attendance (about 3500 including 500 ladies), work accomplished, number of sessions and committee meetings; but it was notable particularly for the intensity of interest in both standards and research.

To say that the "T" in the "Tea Party" stands for "Testing"—the code word used by our printers in referring to our publications—is an oversimplification, unless one includes under "Testing" its various aspects of research, the probing for more and better knowledge for the better evaluation and utilization of materials, and the improvement of testing procedures and the development of new testing tools. The emphasis on research was evident throughout, including the technical sessions, the special lectures, the luncheon talks, and the committee meetings.

An important purpose of the research work, of course, is to provide the basic data needed for the preparation of adequate materials specification, and here, too, the product of the technical committees was impressive, particularly having in mind that this is a Book of Standards year and the committees wished to have the standards under their jurisdiction—both specifications and test procedures—in their best approved form. A tabulation of the actions taken is given elsewhere, as well as a listing of the new standards. The details are given in the reports as preprinted and relatively few changes were made in the preprinted reports.

Similarly, the members have already been supplied—on request—with preprinted copies of many of the technical papers, and copies of many of the remaining papers have since been made available as mentioned elsewhere in the BULLETIN. Anyone interested in studying these reports and papers should avail himself of the preprints or duplicated typed copies.

Awards and Election of Officers

Biographical information on the incoming President Kenneth B. Woods and Vice-President A. Allan Bates appears on page 22. Annually new members are elected to the Board of Directors. Their names and biographical information appear on pages 22–24.

The annual address of the retiring President, Richard T. Kropf, was featured at the President's Luncheon and appears on page 12.

A number of special awards honoring members of the Society were presented. Recipients of these awards and information on their contributions to the Society appear on the following pages.

Special Events

At four industry luncheons, outstanding speakers appraised the present situation and conjectured on the future of their respective industries—Copper and Brass, Road Materials, Petroleum, and Apparatus and Instruments.

An outstanding program was provided by the local committee to entertain the more than 500 ladies who took this opportunity to visit Boston and New England—many for the first time. Sightseeing trips and visits to historical and cultural points of interest were arranged as well as friendly morning "coffee hours" at which to get acquainted.

A "night at the Pops" with dinner and a special concert by the Boston Pops Orchestra under the baton of Arthur Fiedler provided an enjoyable and stimulating evening of entertainment to relieve the tensions of the five-day technical program and schedule of committee meetings.

The local committee deserves unbounded praise for the arrangements made to make the meeting a success. The dinner and Pops concert were the pinnacle of the week and outstanding by any comparison. Other committees contributing substantially to the convenience and success of the meeting from the point of view of those attending were the Hospitality and Information Committee and the Transportation Committee which provided help and advice to those planning to spend additional time in and around Boston or visiting historic New England.

Arrangements were made also by the Entertainment Committee for those interested to visit laboratories and plants in the Boston area. More than 20 companies, government agencies, and educational institutions offered their facilities.

Exhibit of Apparatus and Laboratory Supplies

Ingenious instrumentation and rugged practical applications to research and testing were featued by manufacturers

and distributors of apparatus and instruments at the Society's 13th biennial exhibit. A wide range of items from small, hand-manipulated instruments and electronic control devices through high-temperature ovens and heating elements to giant universal testing machines were displayed by 66 different concerns occupying an exhibit area of over 16,000 sq ft. The exhibit, also, was the largest ever held by the Society.

Photographic Exhibit and Competition

The Photographic Exhibit and Competition also was the largest ever held by the Society. There were 227 entries, including 182 prints on regular mounts, 40 transparencies. All of the metallurgical entries stressed the educational and useful technical value of the prints. Numerous photomicrographs, electron micrographs, and photomacrographs showed attractive patterns and composition, even to the nontechnical viewer. Many of the winners and other interesting entries will be reproduced in coming issues of the ASTM BULLETIN. There was a special stereographic display of metallurgical samples prepared by the Department of the Navy, Bureau of Ships.

Technical Sessions

While a number of the 42 technical sessions were for the essential Society action on committee recommendations, the greater part of the time was devoted to symposia and technical papers. Topics covered included fatigue and the basic mechanisms of fatigue, durability in structures, solvent extraction in the analysis of metals, bulk sampling, ferrous metals, cement and concrete, textiles, road and paving materials, effects of radiation and high-temperature on materials, the effect of water on bituminous paving mixtures, crack propagation, nonferrous metals, soils for engineering purposes, particle size measurement, paper and paper products, radioactivity in industrial water and industrial waste water.

Because of your background of technical knowledge and accomplishments, as well as your familiarity with current trends, you, and your committees can be instrumental in accelerating the present highway program by continuing to sponsor research designed to improve the quality of materials, methods of measuring the physical and chemical properties of material, and to reduce the time and manpower required for material inspection and control.—**John A. Volpe** at the Road Materials Industry Luncheon

Committee Activities

Fifty-seven main technical committees; joint committees with other societies; and ASA Sectional Committees sponsored by ASTM met during the Annual Meeting. The total number of individual meetings of these committees including subgroups was about 900.

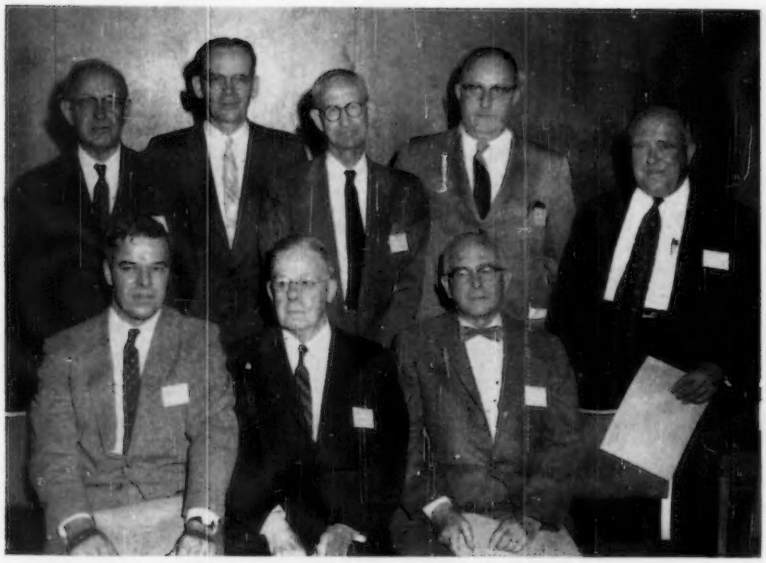
Despite the emphasis on symposia and technical sessions at annual meetings, many committees schedule full programs of subcommittee and section meetings. This, of course, is desirable for the accomplishment of committee work, but because of the large number of meeting rooms required—the number increasing each year—few cities have the facilities to accommodate ASTM annual meetings.

Reports of activities of committees meeting during the Annual Meeting will appear in the September BULLETIN. As the Annual Meeting climaxes the year's committee work, it is fitting that this issue covers in some detail, beginning on page 32, the new standards and tentatives approved by the Society at the Annual Meeting—this is really what the committees have been working on all year.

Hundreds of ASTM members, committee members, and visitors were interested in the widely varied new equipment on display in the Exhibit of Testing and Scientific Apparatus and Laboratory Supplies. In addition to the registrants for the Annual Meeting, a large number of additional visitors came to see the exhibit.

Theodore P. Dresser, Jr., vice-president and chief engineer, Abbott A. Hanks, Inc., San Francisco, receiving the 50 year membership certificate from President Richard T. Kropf.

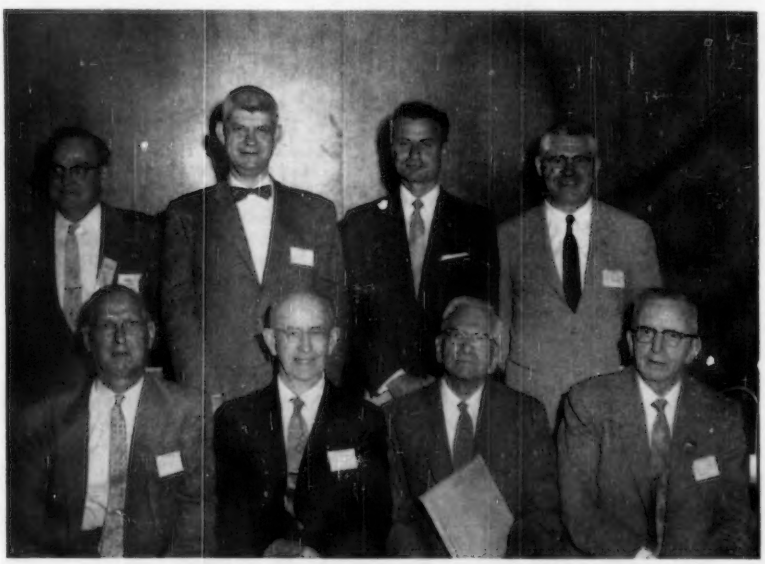
Mr. Dresser, a former national director and very active in ASTM West Coast affairs, represented the other 50 year companies and individual members. He expressed appreciation to the Society for the entire group. Also on behalf of the General Committee for the 3rd Pacific Area Meeting, to be held in San Francisco October 11–16, 1959, he extended a cordial invitation for everyone to attend. An extensive technical program and special entertainment features are being developed.



Forty-Year Members Recognized at the President's Luncheon

(Back row, left to right) James S. Vanick; E. Schulte, representing The Glidden Co., Paint Div.; R. L. Sanford; G. V. Kingsley representing Bohm Aluminum and Brass Corp.; F. G. White representing Granite City Steel Co.; (front row, left to right) E. V. Black representing Lebanon Steel Foundry; Daniel Cushing; and Raymond W. Woodward.

Some of the forty-year members who were present do not appear in the photograph.



Fifty-Year Members Recognized at the President's Luncheon

(Back row, left to right) George H. Harnden, representing the General Electric Co.; J. J. Kanter, representing the Crane Co.; unidentified; H. W. Stuart, representing the U. S. Pipe and Foundry Co.; (front row, left to right) Roland P. Davis; H. H. Scofield; Albert J. Loepsinger; and Theo. Parker Dresser, Jr., representing Abbot A. Hanks, Inc.

Some of the fifty-year members who were present do not appear in the photograph.

Housing

WHILE THE STAFF did everything possible to help the members avoid housing difficulties in Boston, there were several instances where the only course was to substitute less desirable accommodations.

Some difficulties were caused by members writing direct to a hotel for reservations rather than through the housing bureau (or clearing house) that was set up to handle such requests. Last minute changes in requirements, single to twin, or *vice versa*, created problems, and there are still a few members who expect accommodations when they write a week or so before the meeting

National meetings of the Society are always arranged years in advance—and commitments for both meeting and sleeping rooms are secured. After the cut-off period, cooperating hotels will no longer hold space specifically for ASTM, putting a heavy burden on headquarters hotels. This year the Boston Statler committed 700 rooms but cooperated splendidly in extending this to about 950.

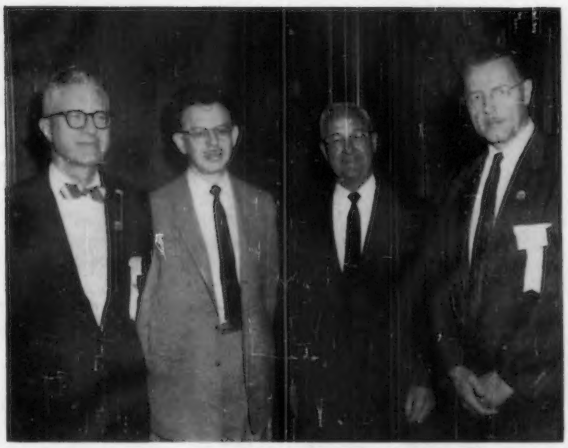
In making your reservations in the future, *please* use our request blank and send it in as soon as your plans are definite. Follow the instructions given. You will fare much better.

ASTM Received Wide Press Coverage

The 61st Annual Meeting of ASTM was probably the most widely publicized meeting ever held by the Society. In addition to two TV broadcasts over WBZ-TV and WGBA-TV, two taped radio interviews were broadcast over radio station WILD. Such well-known newspapers as the *Christian Science Monitor*, the Boston *Globe*, and the Boston *Herald* published daily stories of the meeting's activities.

September 1—Last Day for Annual Meeting Papers Discussion

WRITTEN discussion of papers and reports presented at the Annual Meeting will be received by the Committee on Papers and Publications until September 1. In view of the fact that much of the discussion published in the *Proceedings* is submitted after the meeting by letter, it will be helpful if all who can send their discussion to Headquarters well in advance of this date so that additional time is available to review and refer the discussion to authors for closure.



ASTM Executive Secretary R. J. Painter, Battelle Memorial Institute President B. D. Thomas, Gillett Lecturer Clyde E. Williams, and ASTM President Richard T. Kropf at the Gillett Lecture.

Elmer W. Pehrson, Marburg Lecturer receiving the lecture certificate and congratulations from ASTM President Richard T. Kropf. ASTM Executive Secretary Robert J. Painter looks on.

Outstanding Lectures by Williams and Pehrson

Availability of Raw Materials

Two outstanding lectures, the Gillett and Marburg Lectures, were presented respectively by Messers. Clyde Williams and Elmer W. Pehrson, emphasizing both favorable and unfavorable aspects, of our supply of minerals and raw materials.

Dr. William's Gillett Memorial Lecture, "High Temperature Metals—Their Role in the Technological Future," gave a rather reassuring picture of the basic metals supply and the half-dozen or so very strategic metals on which materials development depend. For the immediate future, at least, the speaker felt that total demands for such metals as cobalt, columbium, chromium, nickel, tungsten, and molybdenum, among others, would be met. Stock piling gives added reassurance. Nevertheless, there still are many problems as we enter the high-temperature age, but Dr. Williams felt a critical appraisal and dedicated effort would help us surmount the obstacles.

In a stirring tribute to H. W. Gillett, whose memory is perpetuated in this jointly sponsored lecture, the speaker noted that his lecture really embodied the results of thirty years of study at Battelle Memorial Institute, initiated and planned by the man in whose honor the lecture is given.

A considerably less reassuring picture was presented by Mr. Pehrson, one of the world's leading authorities, in his Marburg Lecture. Mr. Pehrson was considering raw materials on a very broad basis and usage as compared with Dr. William's studies which related more directly to the high-temperature field. Mr. Pehrson left his large audience with the uncomfortable feeling that a great deal more needs to be done before the United States and the free world can become self-sufficient in any strategic materials. An evaluation of the resources of the communist states shows that they seem to be in a far better position than the free world. Many things might be done and Congress is evaluating these, according to the speaker. There are countless questions including whether some U. S. industries such as mining and petroleum should not have more support in many areas to offset our relatively fast diminishing sources for strategic raw materials. While overseas raw materials can be and are being brought in in large quantities, the wartime possibility of shutting off these sources raise questions as to the soundness of present practices and policies.

Editor's Note: **Both the 1958 Gillett and Marburg Lectures will be published as separate pamphlets.**

Industry Luncheons

The industry luncheons provide an opportunity for the members in special fields to be informed concerning the thinking of leaders in these fields. These same thoughts are transmitted to the membership at large, either through résumé as set forth below or by publication of the complete addresses.

Head Table Guests at the Copper and Brass Industry Luncheon

Left to right are: T. E. Veltford, managing director, Copper & Brass Research Assn.; Philip A. Coleman, vice-president, The Accurate Brass Corp.; D. C. Drucker, chairman, Division of Engineering, Brown University; Bruce W. Gonser, technical director, Battelle Memorial Institute; E. W. Pehrson, chief, Division of Foreign Activities, U. S. Bureau of Mines; R. A. Wilkens, vice-president, Revere Copper and Brass, Inc.; George H. Harnden, consultant, Materials and Processes, Engineering Standards Service, Engineering Services Div., General Electric Co.; Richard T. Kropf, ASTM president, and vice-president and director of research, Belding Heminway Co., Inc.; Rear Admiral Carl F. Espe, USN—The Commandant, First Naval District, Boston; N. W. Fulton, vice-president and general manager, Mackenzie Walton Corp.

Guests at the Head Table of the Instruments and Apparatus Industry Luncheon

(Front row, left to right) Robert J. Painter, executive secretary, ASTM; Edward J. Albert, chairman of the Board, Thwing-Albert Instrument Co. and past president, SAMA; Dr. Charles E. Crossland, acting president, University of Maine; A. T. Goldbeck, consultant, National, Crushed Stone Assn.; Allen V. Astin, director, National Bureau of Standards; and Alfred C. Webber, senior supervisor, Experimental Station, E. I. du Pont de Nemours & Co., Inc., (back row, left to right) David C. Scott, Jr., president, Scott Testers, Inc.; Richard T. Kropf, vice-president and director of research, Belding Heminway Co., Inc. (ASTM president); Col. R. M. Hurst, Ordnance Corps, Department of the Army, commanding, Watertown Arsenal; William T. Alexander, dean, College of Engineering, Northeastern University, and ASEE president-elect; J. J. Moran, technical manager, Sales Dept., Kimble Glass Co., 1958 Award of Merit Winner; and Fred F. Van Atta, assistant secretary, ASTM.

Copper and Brass

In addition to a very interesting survey of the early beginnings of the copper and brass industry in New England brought about in part by readily available deposits of copper and a skilled labor force which then were sufficient, R. A. Wilkins, vice-president of Revere Copper Co., in his address at the Copper and Brass Industry Luncheon on Wednesday, June 25, stressed the great significance to the industry of the work which the metallurgists and technical men have accomplished. Production, and in fact the whole concept of the industry, has shifted from an artisan background to one with a sound technical basis. A native New Englander, Mr. Wilkins mentioned his early experiences in tracing copper deposits. He paid particular tribute to men like Wm. H. Bassett, metallurgist, American Brass Co., an indefatigable worker in introducing scientific approaches in the industry. He worked equally effectively in ASTM, culminating in his election to the presidency in 1934.

The luncheon chairman, G. H. Harnden, also chairman of Committee B-5 on Copper and Copper Alloys which sponsored the luncheon with Committee B-2, described briefly the work of the two groups, noting that Committee B-2 covered refined copper and miscellaneous alloys whereas Committee B-5 concentrated on copper-base products. Committee B-5 has issued over a hundred standards which are widely used throughout the United Stated and overseas. They cover the quality and testing in a broad range of materials and products. Committee B-5 maintains close contact with the Copper and Brass Research Assn.

Instruments and Apparatus

The strategic importance of the apparatus industry both to our economy and to our defense was stressed at the Instrument and Apparatus Industry Luncheon on Thursday, June 26, by the guest speaker, A. V. Astin, director of the National Bureau of Standards. His statements were all the more authoritative because of the outstanding contributions in this field constantly being made by the scientists at the National Bureau of Standards under his direction.

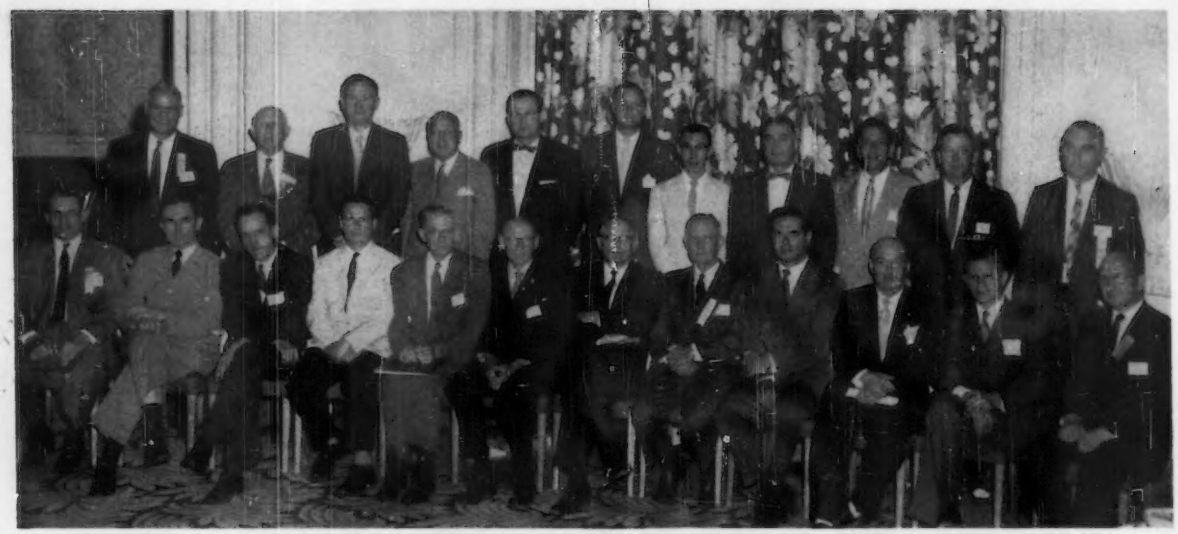
At the outset he noted that "No area of science and technology is more critically affected by instrumentation or the lack of it than that of materials development and evaluation. Technology," he continued, "lies at the center of human activity. It touches upon the dramatic in space exploration. It is a dynamic force in international relations. It has a vital effect upon our national economy." The measurement sciences are directly related to progress, and instrumentation is the most tangible form of progress, according to Dr. Astin.

Broadly, "In general terms, we at the National Bureau of Standards consider instrumentation as the science and art of providing devices and techniques for physical measurement and observation and for processing the results thereof."

Instruments are used in every phase of measurement and experimental de-

Head Table Guests at the Copper and Brass Industry Luncheon

Left to right: Robert J. Painter, executive secretary, ASTM; H. M. Weidner, patent attorney, Revere Copper and Brass Co.; Gordon W. Edwards, vice-president, Kensico Tube Co., Inc.; B. R. Hubbard, manager, Power Cable Div., Triangle Conduit & Cable Co., Inc.; Vincent P. Weaver, metallurgical engineer, American Brass Co.; Elmer R. Stafford, Jr. comptroller, New England Brass Co.; F. B. Beardsley, Jr., secretary-treasurer, Waterbury Rolling Mills, Inc.; J. W. Caum, senior assistant technical secretary, ASTM.



Guests at the Head Table of the Road Materials Industry Luncheon

(Front row, left to right) Raymond E. Hess, associate executive secretary, ASTM; Col. Stanley Dziuban, deputy division engineer, New England Div., Corps of Engineers; Bryant Mather, Secretary, Committee C-9, Concrete Div., Waterways Experiment Station; S. Russell Stearns, Thayer School of Engineering, Dartmouth College; E. J. Kilcawley, Chairman, Committee D-18, professor and head, Div. of Soil Mechanics and Environmental Engineering, Rensselaer Polytechnic Inst.; Donald M. Burmister, professor of Civil Engineering, Columbia Univ., Hogentogler Award winner, S. Bruce Black, chairman of the Board, Liberty Mutual Insurance Cos.; R. R. Litehiser, Chairman, Committee C-1, engineer of tests, Ohio State Highway Testing Laboratory; G. W. Blackwood, president, Dewey & Almy Chemical Co.; A. Allan Bates, vice-president, Research and Development, Portland Cement Assn.; John A. Volpe, president, John A. Volpe Construction Co.; Miles N. Clair, president, The Thompson & Lichtner Co., Inc.; back row, left to right) K. B. Woods, ASTM president-elect, head of School of Civil Engineering Purdue University; W. C. Hanna, vice-president, California Portland Cement Co.; Walter H. Price, chairman, Committee C-9, head of Engineering Laboratories, U. S. Bureau of Reclamation; Carl S. Ell, president, Northeastern University; Clyde E. Kesler, associate professor of Theoretical and Applied Mechanics, University of Illinois; W. S. Weaver, secretary, committee C-1, research engineer, Canada Cement Co.; Tien S. Chang, Instructor, Virginia Polytechnic Institute; A. B. Cornthwaite, chairman-elect, Committee D-4, testing engineer, Dept. of Highways, Commonwealth of Virginia; A. A. Wagner, secretary, Committee D-18, materials engineer, Earth Laboratory, U. S. Bureau of Reclamation; Dillard D. Woodson, acting secretary Committee D-4, Asphalt Institute; Leroy C. Gilbert, senior assistant technical secretary, ASTM.

B. L. Knowles, legislative representative, Associated General Contractors of America, Washington, D. C., was not present when the photograph was taken.

termination and are vital in ASTM work which in turn underlies much of our continuing industrial progress.

The fantastic growth of the instrument industry was noted. From 1947 to 1954 the industry production increased 400 per cent, and certain aircraft specialities were just under 1800 per cent. However we cannot become complacent, according to Dr. Astin. For example, we seem to be lacking badly in the high-temperature field. The Russians apparently can provide calibration services for temperatures far in excess of our present capabilities. While the Bureau expects Congress to help expedite progress, the apparatus industry must assist in developing a full-scale attack.

One major problem is that of direct force measurement. Serious delays will result in important developmental programs unless we can quickly implement better calibration services. Unresolved problems exist in the field of electronic measurement devices but there are also general problems involving miniaturization. The speaker observed that we must give attention to the instruction and development of scientists to meet the challenge of Russian progress in measurement and instrumentation. While a large part must be borne by the National Bureau of Standards because of its strategic position in this area, Dr. Astin pointed out that an even larger responsibility rests with the instrumentation industry. Its measurement research and development programs must be strengthened and accelerated. *Industry must join Government to win the competition.*

Notables Present

At the head table at this luncheon were representatives of industry and Government and the educational field including Col. R. M. Hurst, Commanding, Watertown Arsenal; Professor Wm. T. Alexander, Dean, College of Engineering, Northeastern University and president elect of the American Society for Engineering Education; Chas. E. Crossland, acting president, University of Maine; and past ASTM director, Edward J. Albert, chairman of the board, Thwing-Albert Instrument Co. and former president of the Scientific Apparatus Makers Assn.

This luncheon was sponsored by Committee E-1 on Methods of Testing whose chairman, new ASTM Director A. C. Webber of the Polychemicals Department, Research Division of the E. I. du Pont de Nemours and Co., Inc., presided together with D. C. Scott, Jr., active in ASTM national and New England District affairs and president of his company.

Road Materials

"One of the greatest economic influences of this century" is the way John A. Volpe, first Federal Highway Administrator and president of a very large construction company carrying his name, characterized the new Federal highway program. Progress, growth, social betterment are all embodied in the highway program. "The economic impact of it is distributed in depth. It embodies a large element of economic stability because of the huge backlog of public works and the immediate stim-

Head Table Guests at Petroleum Industry Luncheon

(Left to right, front row) Raymond E. Hess, associate executive secretary, ASTM; J. B. Rather, Jr., assistant director, Technical Services Dept., Socony Mobil Oil Co., Inc.; L. F. Marek, senior vice-president, Arthur D. Little, Inc.; R. C. Alden, retired long-time chairman, Research Planning Board, Phillips Petroleum Co.; the guest speaker, Hoyt C. Hottel, professor, Fuels Engineering, and director, Fuels Research Laboratory, Massachusetts Institute of Technology; William T. Gunn, director, Division of Refining, American Petroleum Institute, toastmaster (left to right, back row) A. Allan Bates, ASTM vice-president-elect, vice-president, Research and Development, Portland Cement Assn.; Harold M. Smith, regional director, Bureau of Mines, chairman, committee D-2; H. J. Ball, professor Textile Engineering, Lowell Technological Institute, (retired), ASTM past-president and Honorary Member; H. M. Hancock, manager, Product Contol Dept., The Atlantic Refining Co., ASTM director-elect; F. W. Schumacher, manager, Everett Refinery, Esso Standard Oil Co.; and Paul J. Smith, standards editor, ASTM

ulus to current economic growth. Travel time is cut greatly. People are kept on the move, and flow of human traffic creates potential customers. Furthermore, these highways strengthen our National Defense and security."

In his talk entitled, "Invention, Science, and Research in the Highway Program," he commended the Society on its outstanding contributions in the field of research and standardization, referring to a number of specific projects where ASTM technical committees have made invaluable contributions.

Forty-one thousand miles of super highways with hundreds of thousands of causeways, interchanges, bridges, etc., are embodied. An area larger than the state of Rhode Island will need to be fenced. He cited some of the remarkable instruments and equipment available now to the road surveyor, designer, and builder. The work on design is colossal; for example, one 8-mile stretch of the New York State Super Highway had 1200 maps alone with thousands of pages of specifications. The electronic computors will be a great help in cutting computation time and saving manpower. They help especially in evaluating alternative routes. Time-wise it has been taking about 54 months to build a super highway which includes 30 months or more for preliminaries and two years of actual construction time. In one state 60 per cent of this time was cut using today's modern equipment.

Mr. Volpe said that ASTM already had done a great deal in developing standards providing suitable materials and surfacing for highways and that we can help in accelerating the highway program by sponsoring research to improve quality and to reduce time for inspection and control. He mentioned a number of areas where more work is needed.

Awards

This luncheon was also featured by two awards, the C. A. Hogentogler award given to Donald M. Burmister, professor of Civil Engineering, Columbia University, for his paper "Applications of Environmental Testing of Soils." This award is sponsored by Committee D-18 on Soils.

The Sanford E. Thompson award, established by Committee C-9 on Concrete in honor of Mr. Thompson, who was the committee's first chairman and who was succeeded as the president of Thompson & Lichtner Company by the luncheon toastmaster, Miles N. Clair, was given to T. S. Chang and Clyde E. Kesler, then at the University of Illinois, for their paper "Correlation of Sonic Properties of Concrete with Creep and Relaxation."

The Hogentogler award was given for Committee D-18 on Soils by Professor Kilcawley, the chairman; the Thompson award by Walter H. Price, chairman of Committee C-9 on Concrete.

Four ASTM committees—C-1 on Cement, C-9 on Concrete, D-4 on Road and Paving Materials, D-18 on Soils—together with the New England General Committee sponsored the luncheon.

Petroleum

Solar energy studies being made at the Massachusetts Institute of Technology were described by Hoyt C. Hottel, professor of Fuel Engineering and director of the Fuels Research Laboratory at the Petroleum Industry Luncheon on Thursday, June 26. Professor Hottel outlined methods that have been studied for obtaining solar heat including the photochemical and thermodynamic methods. He also described the studies that are now under way for using solar energy for domestic house heating, explaining the features of an experimental solar house in Lexington, Mass. While solar house heating itself is not as yet an economical accomplishment, solar heating for domestic hot water systems is practicable, particularly in such locations as Florida where a large amount of sunshine can be depended upon.

Professor Hottel called attention to some needed research on domestic oil heating. He expressed the opinion that the oil industry would be in a much better competitive position with gas if it would develop a cleaner and more efficient oil burner for house heating since, at the present time, there is a tendency to install gas heating even where oil would be more economical and would probably be used if a more satisfactory burner were available.

The luncheon chairman, W. T. Gunn, secretary of ASTM Committee D-2 on Petroleum Products and Lubricants which sponsored this luncheon, described the activities of Committee D-2 in promoting the knowledge of petroleum and its products, and also the extensive standardization program it has carried on since its organization in 1904.

Guests at the Head Table of the President's Luncheon

(Back row, left to right) Raymond E. Hess, associate executive secretary, ASTM; Matthew Reilly, Deputy Mayor of Boston; A. L. MacLean, district vice-president, National Assn. of Purchasing Agents; C. H. Fellows, Detroit Edison Co. (retired), past-president ASTM; M. N. Clair, president, Thompson & Lichtner Co., Inc., and chairman, General Committee on Arrangements; G. O. Linberg, Syntron, Inc., president AATCC; K. B. Woods, ASTM incoming president; J. G. Morrow, Steel Company of Canada, new Honorary Member; J. L. McCloud, Ford Motor Company (retired), new Honorary Member; (front row, left to right) R. T. Kropf, ASTM president; A. A. Bates, toastmaster, ASTM vice-president elect; F. L. LaQue, ASTM vice-president; Truman S. Fuller, consultant, new Honorary Member; E. W. Pehrson, U. S. Bureau of Mines, Edgar Marburg Lecturer; H. J. Ball, Lowell Technological Institute, new Honorary Member; Henry Grinsfelder, Rohm and Haas Co., chairman, Committee on Award of Merit; W. L. Hyland, Fay, Spofford and Thorndike, president, Boston Society of Civil Engineers; R. P. Mahan, manufacturers' representative, chairman, New England District Council; R. E. Shillady, vice-president, New England Electric System, and past-president, National Assn. of Purchasing Agents; Robert J. Painter, executive secretary, ASTM.

A Continuing and Vital Challenge

A Stimulating Address by the President—R. T. Kropf

SINCE the very beginning of history, man has faced the future with great courage and with feelings of deep concern over the dark unknown which lay ahead. It was with this great courage that ancient man and all of those who have gone before us met and mastered the great challenges of their unknown future. It is to them we are indebted for our great heritage of today. However, with this priceless inheritance we have also fallen heir to the great responsibility of meeting and mastering the great challenges of our future.

You may well say that ours is a far greater responsibility today than those of yesteryear, with our ever accelerating progress. Let us not, however, permit the magnitude of the absolute values obscure the relative factors involved. Leave for a moment, the consideration of our problems of the future and, in the "time machine" of your imagination, transport yourself from the comfort and security of your present surroundings, back twenty-five thousand years to a damp, dark cave in what is now Daurdogne, France.

In the Beginning

Clad only in a tattered pelt, the shrill wintery blasts outside the cave chill you to the bone, and the howls of the wild animals stalking you chill the very marrow of these already well-chilled bones. You are cold; you are hungry; you may be desperately ill. You are superstitious; you are afraid; you are worried. Worried about the "future?" Hardly, since you are worried about your next meal; you are worried that you might not live to eat that meal even if you knew from whence it might come. Would you trade our responsibilities of today for those of primitive man? I am certain that no one among us would entertain such an idea—for, over the past 250 centuries our progress has been great and the benefits which have accrued to mankind are virtually beyond measure.

Let us pause for a moment with our cave men to witness that which historians consider to be the first major step in the history of civilization. We find our primitive man using simple stones as tools and as weapons for killing animals and fighting his enemies. Several of these stones he treasures above all others because they are of a more usable shape and have a somewhat sharp edge, and he eagerly seeks more of them. Then, through his primitive means of communicating ideas, he learns that there is available in a strange and distant place —actually relatively but a short distance by our standards—a marvelous NEW MATERIAL which can be shaped into better, more efficient, sharper tools and more effective weapons. This material was not easy to obtain and must meet certain requirements.

Earliest Research and Standards

It is of particular interest to us of the American Society for Testing Materials, which is dedicated to "research and standards for materials," that we are observing, as primitive as it may be, the very earliest "research and standards for materials." Now, what was this marvelous new history-making material? It was flint! Not the common variety that had lain on the surface of the earth, eroding for countless centuries, but the kind which was dug from

beneath the surface. Primitive research had shown that this flint could be "flaked" so that it could be worked into various shapes with sharp edges. This must have been called "high-test flint," and before our cave man would accept it, he tested it for "flaking" by striking together two pieces, one held in each hand. Here we observe the earliest accepted "test method and standard for material." Yet, as intriguing as this may be because of our specific technological interests, we must not lose sight of the significance of this to the progress of civilization.

More New Horizons

To mankind this was not only a new material—it was a NEW HORIZON. Historians tell us that this may be considered the primary stimulus of our civilization. Our cave man now traveled many miles to the flint mines of northern Europe, some of which in existence today are reported to be over 17,000 years old. Ancient man traded furs and amber for this "high-test flint," and it is generally agreed that this is the very first evidence of commerce or trade. This stimulated the development of various means of the better communication of ideas, and certain archeologists claim that it can be shown that there were even traveling flint salesman at that time.

The centuries moved slowly, and the next step in progress was to be marked by a new material and a NEW HORIZON with the discovery of copper. Progress continued to move at a faster pace and we arrive at another NEW HORIZON, on which we find a new material—bronze! Associated with this "royal metal," as it was often described, the horizon of civilization expanded rapidly to still another NEW HORIZON. Here we find another new material—iron, and with this material the horizons of civilized man have extended almost beyond our comprehension.

As we have made this rapid passage through the pages of history there is one fact that stands out above all others. The history and progress of civilization is inseparable from materials. This has long been recognized by historians who have described these periods of our history by the materials we saw on each NEW HORIZON: the Stone Age, the Copper Age, the Bronze Age, and our own Iron Age.

Materials Use—A Yardstick

It is quite logical, therefore, that material usage may be considered a yardstick of the progress of civilization, and in order that we may picture this growth let us consider the usage of iron in our period of this Iron Age. In the middle of the last century about 175 lb of iron were consumed per capita per annum in the highly industrialized countries. By the turn of the century, we were using approximately 440 lb; and by 1950 we were consuming about 1000 lb per capita per annum. We entered 1957 with a rate of approximately 1300 lb, which means we have been doubling our consumption of iron approximately every thirty-five years. An even more dramatic measure of our progress is recognized in the use of electrical energy. Here we find that we double our use of electricity approximately every ten years!

Thus we may contemplate our future with some quantitative estimate of the magnitude of the challenge which lies ahead. It is but necessary to consider the growth rate of our population and compound this with our accelerating usage rates of materials and energy to develop an array of astronomical numbers which represent the requirements of our civilization by the year 2000. Time will not permit a recapitulation of these data; however, they may be dramatically translated into terms of the *scientific and engineering brainpower* required to meet this *great challenge* less than forty-two years hence. This era of exploding technology will require, by the year 2000, more than ten times the number of scientists and engineers we have among us today; and, what is far more serious, this is roughly three times the number which will be produced by our educational system at our current rate of production. This situation has deeply concerned thinking men and women in every walk of life, and enlightened people everywhere have put their shoulder to the wheel in an effort to solve this vital problem.

ASTM's Great Responsibility

You can be very proud of the important role which you individually and collectively through our great American Society for Testing Materials are playing and are destined to play in this important program. To understand fully the importance of ASTM and its position of responsibility in America and the entire civilized world, it is important to recognize two fundamental facts: First, materials are the common denominator of all engineering; and, second, the ASTM must be correctly described as the "American Society for Materials." Thus, ours is the sacred trusteeship of that vital factor—materials—common to all engineering, and essential to all progress.

The unreserved support and respect given the ASTM by the individual members of every branch of the scientific and engineering professions, by the many educational and research institutions of the nation, by our ever growing industry, by the many agencies of our various local, state, and federal governments, and above all by nontechnical people of every walk of life, is mute evidence of the recognition of the important role it has played and is destined to play in our future. It is not my intention to recapitulate here the details of the outstanding contribution which the ASTM has made and is continuing to make, since this is well documented in, and by, our many publications and our monumental Book of Standards. It should be pointed out, however, that this support and respect has been earned by the ASTM through the responsibilities which it has assumed and discharged with distinction, through the dedicated efforts of its members, its myriad committees, and its outstanding staff.

Proud as we may be of our accomplishments, our *great challenge* still stands before us. On every NEW HORIZON of every new day, we can truly say there is a new material with the need for new and more research and standards which is the fundamental responsibility of ASTM. Coupled with this is the responsibility of the more effective communication of the information related to this common denominator of all engineering to all engineers and scientists and thereby multiply their effectiveness and thus compensate in part for the anticipated serious shortage in their numbers. Ours is the responsibility to stimulate and to assist in the field of scientific and engineering education, particularly in those areas related to materials. These are but a few of our responsibilities which will continue to grow and to change with the passing of time.

Working for the Future

As you are aware, your Society is deeply conscious of these challenges and responsibilities and has currently underway, extensive programs on long-range planning, education, and other matters; to mention but one, the anticipated mushrooming demand for publication growth through this exploding technology. Each member and each committee is playing a vital part in this program, and it is with pride that we can say that ASTM is a working Society and that it is working for the future!

Likewise, it is unnecessary for me to say, I am sure, that I share your enthusiasm and confidence in the ASTM and in its ability to meet every *great challenge* on every *new horizon*, since my thoughts of our distinguished Society, its members and its future, were well expressed by Henry David Thoreau, the Sage of Walden Pond, when he said in "What I Lived For":

"To him whose elastic and vigorous thought keeps pace with the sun the day is a perpetual morning."

Speakers at the Materials Research Frontiers System

(l. to r.) Arthur von Hippel, Massachusetts Institute of Technology; E. P. Stevenson, Arthur D. Little, Inc.; B. H. Billings, Baird-Atomic, Inc. J. J. Antal, Ordnance Materials Research Office; A. H. Batchelder, California Research Corp., speaking for A. L. Lyman; Herman Mark, Brooklyn Polytechnic Institute; W. R. Hibbard, General Electric Co.; W. W. Shaver, Corning Glass Works.

Symposia and Sessions

Research Frontiers

Materials Made to Order

Possibly some of those attending the Materials Research Frontiers Symposium at the Annual Meeting thought they had seen everything when Prof. Herman Mark, using a hammer, drove a plastic nail through a piece of hardwood. While this is not the usual ASTM method for demonstrating toughness of a material there was no question as a result of the demonstration but that this particular plastic nail had something. That something, according to Professor Mark, was an angular molecular structure which is the kind of polymer structure to strive for if a tough plastic is the object. Examples of this angular or kinked type of polymer are the new polycarbonates, recently announced by the General Electric Co. under their trade name LEXAN. Professor Mark described other types of polymers and indicated how their properties were derived from a deliberate ordering of the polymer structure through special catalysts and other polymerization techniques.

Professor von Hippel, professor of Electrophysics at Massachusetts Institute of Technology, indicated that very often in testing engineering materials we are not testing the inherent or possible qualities of materials but rather we are testing the effects of the "fly" that accidentally got into the compound during preparation. He indicated that scientists and engineers might work more closely, through the new science of molecular engineering, to realize more nearly the properties that are possible from appropriate manipulation of the atoms in the material.

Dr. Antal in speaking on nuclear matters emphasized the importance of purity. He indicated that the neutron absorption of the elements varied by about one hundred million and that if a low neutron absorption is desired in a material the boron content must be less than one part per million. He pointed out that under radiation conditions the ionization that occurs in metals is almost instantly erased through conduction. In insulating materials this is not the case and they are, therefore, more easily damaged or destroyed by radiation.

Other speakers discussed various aspects of the research frontiers for materials. New developments in glass and ceramics were discussed by W. W. Shaver of Corning Glass Works. W. R. Hibbard of General Electric Co., speaking on physical metallurgy, showed some fascinating films of dislocations in metals taken under the electron microscope.

The Symposium was sponsored jointly by the ASTM Administrative Committee on Research and the ASTM New England District local committee.

Tribute to the Late H. H. Lester

In introducing the Symposium, both Walter J. Smith of Arthur D. Little and ASTM Executive Secretary Painter paid tribute to the late H. H. Lester for his considerable contributions to the Society, particularly in the research area. As a member of the Administrative Committee on Research he had urged that a symposium of this nature be held and it is fitting that the paper by J. J. Antal of Watertown Arsenal, "Materials in the Nuclear Age," was dedicated to the memory of Dr. Lester.

Bulk Sampling

The Quality of Coal Is "Out of Control"

Proper sampling procedures can contribute much to the adequacy of specifications as well as toward insuring sound decisions. At the two-session Symposium on Bulk Sampling the problems related to sampling coal were discussed by B. A. Landry of the Battelle Memorial Inst., and W. M. Bertholf, Colorado Fuel and Iron Corp. In the vigorous discussion that followed these papers, it was evident that not all the problems related to coal sampling had been solved. Since coal is a variable material and the variability cannot be predicted by the usual statistical methods, it is necessary to introduce factors in the statistical models to cover the unpredictability of the variability. As it was brought out in the discussion, the quality of coal is "out of control." This is in the language of the quality control engineer who says that the product is in control as long as the variability does not overstep the maximum and minimum limits on the control chart.

J. L. Gioele of the Carborundum Co. discussed some of the problems associated with abrasive grain and ore car sampling. In a prepared discussion N. F. Knowlden of American Cyanamid Co. indicated that while management often complains of the high cost of bulk sampling studies, such studies are usually worth the effort, as proper sampling procedures based on adequate studies can much more than pay for the cost of the studies.

W. E. Deming discussed some of the purposes and philosophy behind bulk sampling, considering some of the legal aspects. He indicated that proper sampling as well as other statistical techniques should be worked out jointly by the statistician and the man who knows the subject matter.

Metals

High Temperature

New Data on Copper-Base Casting Alloys

To help to fill the need for data covering various mechanical and physical properties of copper-base casting alloys, two papers were presented in one of the sessions on High Temperature.

The paper on "The Creep Properties of Three Low-Shrinkage Copper-Base Casting Alloys," by W. F. Simmons and J. G. Kura of Battelle Memorial Institute, included creep and creep-rupture data for three alloys at 350, 450, and 550 F. The alloys studied were 80-10-10, 85-5-5-5, and Navy M. A companion paper on "Mechanical and Physical Properties of Three Low-Shrinkage Copper-Base Casting Alloys," by J. G. Kura and R. M. Lang of Douglas Aircraft Co., Inc., presented data on 16 mechanical and physical properties of these alloys at temperatures ranging from minus 40 to 550 F.

The data in these papers constitute the first portion of a program in which additional alloys will be studied. The testing program to date was completely described and information was given on the chemical composition, quality of the melts, and soundness of test bars used in determining the properties.

Crack Propagation

This session was arranged in answer to a suggestion by the ASTM Administrative Committee on Simulated Service Testing that the Society should pay more attention to the mechanism of structural failures. It was a tribute to the subject and to the speakers that approximately 150 people attended the session which ended around 11:15 p.m.

Last on the program was a film by the Naval Air Materials Center showing a full-scale test to determine the effect of shrapnel on the various portions of a modern fighter wing. Previously, three general papers by speakers from Watertown Arsenal, the U. S. Naval Research Laboratory, and the General Electric Co. described principles for evaluating crack propagation of materials and structures. Discussion of these papers was so pertinent that the session chairman permitted extra time, resulting in the late adjournment. Two other papers were presented by E. P. Klier, Syracuse University Research Inst., and S. Yukawa, General Electric Co., describing the hydrogen embrittlement of high-strength steel and the size effects of a Ni-Mo-V steel in a slow notch bend test.

Ferrous Metals

In spite of many committee meetings scheduled at the same time, about 150 people attended this Monday evening session featuring a wide range of subjects.

Mary R. Norton described work at the Ordnance Materials Research Office on the brittleness of 3140 steel after tempering. Support was given to the view that isothermal temper embrittlement simply reflects the change in impact properties due to the changes in microstructure. A paper sponsored by the Continental Can Co. and presented by E. J. Ripling described for 1340 steel the improvement of toughness as well as yield strength by a warm prestraining procedure. Other methods for improving toughness, such as tempering, usually have a detrimental effect on yield strength.

Battelle Memorial Institute and U. S. Steel Corp. jointly gave the results of an intensive program to determine the effects of strain rate and temper rolling on the strain aging of rimmed annealed steel. Yield point phenomena and work hardening characteristics were found to be markedly affected.

An investigation indicating that the upper yield point in bending is dependent on specimen size was reported by C. W. Richards of Stanford University. This provides further support for the brittle fracture analogy for the yielding of weld steel. J. D. Lubahn of the General Electric Co. reported in another paper that the hysteresis loop in cyclic loading may be used as a possible source of damping characteristics, an important property in these days of high-speed flight and rockets.

Finally experimental data were presented by L. C. Marshall, Link Belt Co., on the elevated temperature properties of malleable iron. The data indicated a favorable comparison with other cast metals, including some with varying alloy compositions.

Non-Ferrous Metals

Alloy Described for Missile Applications

A high-damping magnesium alloy for missile applications was described at the Session of Non-Ferrous Metals by W. Babington of the Bell Telephone Laboratories. He discussed the properties of a new alloy known as K1-X1, which was developed with the cooperation of the Dow Chemical Co. The alloy, consisting of 0.6 to 0.7 per cent zirconium and the balance magnesium, was proved better than conventional alloys for missile applications, such as in the Nike-Hercules missiles, where limitations on weight prohibit the extensive use of shock mounts. In the design of these missiles, resonant frequency was an important factor. After careful study, a material was chosen with high damping effects, making it suitable for shock resistant use.

Four other papers were presented at the Session, including "Evaluation of a Single Shear Specimen for Sheet Material," W. W. Breindel, C. L. Seale, and R. L. Carlson, Battelle Memorial Institute; "A Study of the Variability in the Mechanical Properties of Grade A Phosphor Bronze Strip," M. N. Torrey, G. R. Gohn, and M. B. Wilk, Bell Telephone Laboratories, Inc.; "Isochronous Stress-Strain Curves for Some Magnesium Alloys Showing the Effects of Varying Exposure Times on Their Creep Resistance," R. B. Clapper, The Dow Chemical Co.; "Young's Modulus of Magnesium Alloys as a Function of Temperature and Metallurgical Variables," R. W. Fenn, Jr., The Dow Chemical Co.

Analysis of Metals

Solvent Extraction Grows in Favor

In chemical analysis of metals it generally is necessary to separate the element to be determined in some manner. Solvent extraction separation methods have grown in favor because of their simplicity, speed, convenience, and versatility.

Since solvent extraction procedures are only as good as the reagents used to produce the extractable compounds, papers by F. L. Moore, J. C. White, both of Oak Ridge National Laboratory, and R. J. Hynek, Allis-Chalmers Manufacturing Co., were devoted to detailed discussions of the characteristics and applications of three of the newer organic reagents—tri-*n*-octylphosphine, thenoyltrifluoroacetone, and 8-hydroxyquinaldine. The first two have proved particularly valuable in solvent extraction procedures employed in connection with rare earths and radiochemicals. Numerous references to the literature cover sources of additional information on these reagents.

The basic principles involved in solvent extraction in ternary systems consisting of water, a mineral acid, and an organic solvent were discussed by R. L. Pilloton, Electro Metallurgical Co., Division of Union Carbide Corp.

He described phase diagrams of ternary liquid systems, and discussed convergence of tie lines in ternary liquid systems when related by certain equations, and the significance of convergence points in predicting separations that are possible by liquid extractions.

Extraction with organic solvents and direct aspiration of the solution into an oxygen-fuel flame has been found to produce large increases in emission intensity in flame spectrophotometric determinations, the increase in intensity sometimes exceeding 100-fold. J. A. Dean, of the University of Tennessee, discussed the capabilities and advantages of methods employing organic extraction prior to flame spectrometric determinations. It was indicated that such methods should be attractive to laboratories considering emission spectrography but whose work loads, diversity of sample compositions, or cost factors have mitigated against its adoption.

Fatigue

Failures Begin with Slip Movements

Fatigue failures at low amplitudes of stress begin as fine slip movements in a fatigue band, thus producing sharp notches, peaks, and other forms of surface disintegration. This was discussed in a study of "Recent Observations on Fatigue Failure in Metals," by W. A. Wood of the University of Melbourne, Australia. The paper was one of seven in a Symposium on Basic Mechanisms of Fatigue sponsored by ASTM Committee E-9 on Fatigue.

To show more directly how a disturbance might initiate a crack, Mr. Wood sectioned the tested specimens at small angles to the surface. The sections were then examined by optical microscope at magnifications of 500 to 1000. In this way the disturbance below the surface could be viewed at total effective magnification up to 30,000 times. Observations thus made seem to indicate that failure occurs when disturbance in the form of fissures become numerous enough to weaken the metal.

Typical effects of surface disintegration were illustrated by examples from copper and brass subjected to alternating torsion. In his paper Mr. Wood showed how continued reversal of the specimens can give rise to an unusually high number of slip movements, many of which escape to the surface of the metal. Here they build up the surface disturbances of continually increasing strength. As a result irregular contours and sharp notches strong enough to start a crack are developed.

The papers and discussions presented in this symposium contribute much to our knowledge of fatigue.

Statistical Analysis of Data

With statistics playing an increasingly important role in the analysis of fatigue data, the papers presented in two sessions on fatigue take on an added significance.

W. S. Hyler, and R. J. Favor, both of Battelle Memorial Inst., and L. D. Tarasov, of the Norton Co., in their paper "Distribution of Fatigue Failures in Flat Hardened Steel Bars," analyzed the locations of fatigue nuclei in flat hardened steel bars tested in cantilever bending. A study was made of the kind, size, and depth of inclusions in those series of bars for which failure was predominantly subsurface. The failure distributions were analyzed by constructing histograms and by plotting graphs of cumulative percentage of distributions.

Mr. Hyler pointed out that the fatigue program was aimed at studying as many grinding and tumbling variables as possible. The study concluded that the depth of nucleation appears to be related to processing variables. The data also indicated that there was little or no tendency for the fatigue failures to originate at the corners of the specimens. This is contrary to some statements in the literature. The evidence of this study suggests that inclusions remote from the corners were just as detrimental.

The statistical approach to the analysis of fatigue data was also employed in a paper on "Tentative Fatigue Strength Reduction Factors for Silicate Inclusions in High-Strength Steels," by H. N. Cunnings, F. B. Stulen, and W. C. Shulte of Curtis-Wright Corp. This paper described some studies of the quantitative aspects of the effect of nonmetallic, nonmalleable inclusions on the fatigue strength of specimens of aircraft quality SAE 4340 and 4350 steel. According to the authors, the medium- and long-life fatigue strength of the steels studied decreased substantially for each increase of 0.001 in. in the size of the inclusions, particularly at high hardness levels.

Construction Materials

Durability in Structures

The Symposium on some approaches to durability in structures was well-named, for there is no single approach in achieving durability. Each aspect must be covered—the individual materials, connections, foundations, environment, and use. Possibly due to the New England setting, one listening in on the symposium was reminded of "The Wonderful One Hoss Shay," where each element needed to have meticulous attention. In the same vein, the several authors of the symposium discussed the various factors affecting durability of structures, clay tile, concrete, structural sandwich constructions (including some long-time exposures in typical structures), and the effect of atmosphere on masonry and related materials. Many more materials and elements of construction would need to be covered. To orient the thinking and to show just how much is involved, Mr. Legget of the National Research Council of Canada presented a discussion of what is involved in durability or, as he put it, "Service Life," which depends upon many things, including not only intended use (occupancy) but the economic considerations as well. There are many variables that need consideration, including the weather, as was so excellently brought out in the concluding paper by F. W. Reinhart of the National Bureau of Standards, who had many records over the years, showing the difficulty of comparing simulated (accelerated) testing with actual exposure, when there is no standard for comparison.

Cement and Concrete

New Study Tools Advance Applications

One would think, perhaps, that with a material as old as cement, there is nothing more to be learned. This is far from the case, as was evident at the meeting, for with new applications, new methods of construction, and particular new tools available for study, progress is constantly being made toward a better understanding of the material. At one session, a report was presented on studies made at the University of California on calcium-aluminate admixture for expansive cements. There were also discussions of the causes of false set in portland cement. Stanton Walker called attention to the variation in portland cement and speculated on means for securing a more uniform product.

The advent of prestressed concrete in highway construction has provided a challenge to the testing engineer. One

paper presented an interesting description of methods and procedures devised and used to achieve control of high-quality concrete construction on the Northern Illinois Toll Highway, involving petrographic tests of aggregates, finish screening of coarse aggregates, and semiautomatic batching plants. Statistical analysis was used for the control of strength of concrete and techniques were described for making tension tests of the prestressed wire strands, all of which involved ingenuity because of the lack of standard test methods in this new field of concrete construction.

The need for a practical reflectance test for concrete curing materials was discussed in a paper by C. C. Rhodes and others of the Michigan State Highway Department. The use of silicones for extending concrete highway durability was illustrated in a paper by H. L. Cahn and R. V. Mackey, Jr., General Electric Co. particularly when nonair-entraining cement is used. An interesting point made by the authors was the added safety factor incorporated in the treated concrete which retains its color even when wet, thus retaining its light refractance values.

A research program on the effectiveness of pozzolanic materials in improving the resistance of concretes to sulfate attack was described in a paper by Milos Polivka and E. H. Brown of the University of California. The most satisfactory test procedure was found to be that of complete immersion in the selected sulfate solution and that the most consistent indication of potential resistance is obtained from a photographic record in conjunction with observations of weight loss.

It is astonishing how many aspects of concrete came up for discussion. It was truly indicative of the emphasis on testing and research that was so evident throughout the meeting. For example, a very extensive research program on long-time creep and shrinkage tests of plain and reinforced concrete conducted at the University of California was described. The effect of fine aggregate characteristics other than grading on the strength and durabilities of concrete received considerable discussion. Also, the use of blast-furnace slag in air-entrained concrete was discussed from the point of view of the effect on strength properties.

Details of test procedures, such as the method of capping of concrete cylinders still needs refinement.

The presentations in regular sessions was augmented by many more in committee meetings, where the greatest part of the meeting was devoted to considerations of new procedures and modifications of existing ones.

Effect of Water on Bituminous Paving Mixtures

The effect of water on human beings has been considered both a blessing and an evil. The destructive effect of water is well known in such violent examples as cloudbursts and floods. The destructive effect of just ordinary rainfall and the presence of water in a highway may be little known to the highway user but the highway engineer is painfully aware of its effect as its presence contributes to the failure of an otherwise perfectly well-designed pavement.

The five papers of this symposium discussed the various factors which play a significant part in the behavior of bituminous paving mixtures when exposed to the stripping action of water.

The behavior of bituminous pavements as influenced by moisture was presented by W. K. Parr, University of Michigan and secretary of the Association of Asphalt Paving Technologists. Mr. Parr, through contact with engineers representing states and provinces, cities, counties, and producers, along with his own experiences, classified the behavior of various types of bituminous pavements. The contributing factors associated with each type of pavement were summarized, and it was evident that if all elements of selection and control of materials used, as well as conditions of application, are carefully followed, there can be ample assurance of successful road performance.

In considering the important properties of aggregates which affect the water resistance of bituminous-coated aggregates, surface energy was considered by J. M. Rice, National Crushed Stone Assn., to one of the most important, above that of composition, surface texture, surface coatings, particle size, surface area, porosity and absorption, and chemical reactivity.

The correlation of laboratory tests with field performance is an old subject. E. W. Klinger and J. C. Roediger, Esso Research and Engineering Co., reviewed a long-range program of correlation which involved the use of a laboratory circular track installation combined with a static immersion test. This research was tied in with a twelve-year program of field observations of an experimental pavement. It was found that the static immersion test annually predicted the initial ability of cutback asphalt to coat and adhere to damp or wet aggregate but did not provide correlation with the service performance as found by field observations. The authors advocated new laboratory methods which must be developed based on correlation with long-time observations of pavements exposed to traffic.

Additives, such as chemical agents, to aid in coating aggregates under adverse conditions have been commercially used for some time. P. F. Critz, Bureau of Public Roads, presented a study of nine commercial additives. The general conclusion was the bituminous mixtures in which additives were used would retain greater resistance to moisture as measured by the immersion-compression test.

Considerable discussion followed the presentation of a paper by W. H. Goetz, Purdue University, on methods of testing for water resistance of bituminous paving mixtures. Professor Goetz reviewed the most common test methods which range from the measurement of interfacial tension to simulated traffic tests, pointing out the deficiencies which are associated with accelerated action procedures which involve artificial conditions. The effectiveness of the immersion-compression test procedure was the primary subject of this discussion in connection with this paper.

Test for Skidding Resistance

The familiar highway sign "Slippery When Wet" has been long associated with highway pavements. Modern design of mixtures, as well as a flattened crown of the cross-section, have materially decreased this type of danger in the case of bituminous mixtures. However, antiskid characteristics still remain one of the major objects of research. J. W. Shupe of Purdue University described a laboratory method for determining the skidding resistance of paving mixtures. The procedure used is based on the fact that many road surfaces, whether they are portland cement or of bituminous materials, have possessed adequate wet skidding resistance when new. The change in skidding resistance of paving surfaces due to the polishing effects of traffic is disclosed in the tests which have been run at Purdue University. The apparatus consists essentially of a small circular track on which a testing shoe rotates which is in contact with a prepared specimen.

A. B. Brown, Standard Oil Company of Indiana, in his paper of Objective Appraisal of Stripping of Asphalt from

Aggregate, based his work on the fact that aggregate used in road construction is preferentially wetted by water rather than by asphalt, or is hydrophilic. The use of a tracer technique involving a water-soluble lithium salt for the tracer and the flame photometer for the analysis was used. It was concluded that the lithium tracer salt method did not prove to be an absolute measure but is better than physical methods in that it is free from the subjective bias of the observer.

The California State Division of Highways has not been satisfied in the past with the asphaltic products which have been furnished them and have desired to establish requirements that would give them materials with the desired properties. A field experiment and laboratory study of slow-setting paving grade asphalt in air-field pavement construction was conducted from which a new specification was developed. R. A. Chisholm presented a paper on the work, together with a summary of data of tests. These tests involved both aggregates and asphalts prior to their use and check tests during construction. It was the recommendation that present requirements for paving grade asphalts shall be the product of distillation to the grade specified without the addition of other materials.

The deterioration of asphalt binders in service and in the laboratory was the subject of research by R. F. Sparlin, consulting engineer. Limited laboratory experiments were carried on to evaluate the effect of ultraviolet light as a destructive agent. The author reported that the results of these tests, though limited, indicate that ultraviolet energy of the particular wavelength described in the paper is capable of producing measurable increases in viscosity in films of asphalt which are sealed from the atmosphere.

Lightweight aggregate has been used primarily in portland-cement concrete. The suitability of this aggregate in bituminous mixtures was described by J. C. Wycoff, Southern Lightweight Aggregate Corp. The usefulness of lightweight aggregate was illustrated in the saving of thousands of tons of dead load in long span bridges and large structures. The investigation involved the use of the Hubbard-Field stability test, compressive strength test (ASTM Method D 1074), the test for effect of water on cohesion (ASTM Method D 1075), and field tests involving the drying, mixing, and performance of a lightweight bituminous plant mix. The author made the very definite conclusion that structural-grade lightweight aggregate is suitable to the manufacture of asphalt lightweight plant mix.

Soils

Certain properties of soils, of soil-cement mixtures, and of chemically treated soils were covered in this symposium sponsored by Committee D-18 on Soils. The properties covered include shear strength and elastic properties of soil-cement mixtures under triaxial loading, soil moisture suction, mechanical behavior of chemically-treated granular soils, specific gravity of montmorillonite clay constituents, and compressibility of sand. Also included in the symposium was a method for measurement of soil pressure on a laterally loaded pile.

Of particular interest was the discussion of soil moisture suction as a measure of the moisture status of unsaturated soils. Both the significance of soil moisture suction and methods for measuring it were discussed. Transmission of moisture through soils or between different soils was held to be more directly related to soil moisture suction characteristics than to water content on a weight basis or on a percentage saturation basis.

Probably the most controversial paper covered the specific gravity of montmorillonite clay constituents and a method for detecting qualitatively the presence of montmorillonite clays in soils. The method is based on some rather unique changes in the apparent specific gravity of soils containing montmorillonite clays when such soils are heated. Discussion brought out some strong differences of opinion as to whether apparent changes in specific gravity of the magnitude reported in the paper could really represent measurements of specific gravity or whether other factors were really entering into the values reported.

Soil Testing in Highway Design and Construction

The broad range of soil engineering problems as applied to highways were indicated by Edward S. Barber, University of Maryland, in a paper presented at the Symposium on Application of Soil Testing in Highway Design and Construction. Numerous examples from the author's experience were related illustrative of identification, compaction, weathering, scour, expansion, and many other factors. Typical was the example of scour during floods around a concrete bridge pier founded on piles, when the flood flow would gouge the river bed to a point well below the base of the concrete, leaving only the piles supporting it. After the flood the stream bed would fill in again and maintenance inspection might fail to disclose the critical condition. This, according to the author, accounts for highway maintenance records generally reporting either "no scour" or "no bridge!"

On extensive highway subsurface exploration projects involving both soil and rock, diamond core drilling machines, power augers, and electrical resistivity units should be used as a team according to D. G. Shurig and E. J. Yoder. Their paper described the use of these exploratory tools to obtain subsurface data on the northeastern extension of the Pennsylvania Turnpike. Efficient performance depends on the ability of the engineer in charge to predict subsurface conditions accurately before field sampling and testing.

Robert W. J. Pryer, Quebec, North Shore and Labrador Railroad, presented a paper, written jointly with K. B. Woods, on the exploration of the banded sediments found in the difficult terrain along the Quebec, North Shore and Labrador Railroad. The soils which have proved to be troublesome from a slope stability aspect were described as generally stiff, fissured, silty clays. The soils profiles developed from the boring and laboratory data are expected to be of value in the planning of maintenance operations.

The compaction of granular soils presents problems more difficult than other types, according to E. J. Felt, Portland Cement Assn. Data were presented for several cohesionless soils using various methods of compaction. Vibration was used rather than dynamic rammer compaction, as used in ASTM Method D 698. The author found that the vibratory-table methods readily compacted the granular-type soils to uniformly high maximum densities. A test method was presented which would be usable with both fine-grain and coarse-grain cohesionless materials. This apparatus should be used for determining both minimum and maximum densities of zero moisture.

G. Joslin, Ohio State Highway Testing Laboratory, described the development of three typical sets of moisture-density curves and a circular slide rule which have been used successfully for the control moisture and the compaction of soils in the construction of soil embankments by the Ohio Department of Highways.

A soil classification scheme based on compaction tests was the subject of a paper by J. L. McRae, U. S. Army Engineer Waterways Experiment Station. The author proposed the use of laboratory compaction tests, conducted at three compaction efforts, the results of which are plotted in terms of optimum dry density *versus* compaction

effort in energy per unit volume, thus giving a straight line relationship with semilog plotting. This provides a general soil classification index which can be very helpful in establishing compaction requirements for different soil types and in predetermining the approximate amount of compaction effort likely to be required on each particular soil in the field.

Chemical Products, Water, and Instrumentation

Paper

Knit Paper, Nonwoven Fabric Need New Tests

Committee D-6 on Paper and Paper Products sponsored a Symposium on Paper and Paper Products—New Developments with Accompanying Requirements for New Testing Methods. An historical account of paper testing from the earliest weight tests, which were initiated for tax purposes in 1711, to radioisotope beta-ray thickness gages and identification of fibers by the electron microscope was presented by W. R. Willetts and F. R. Marchetti. K. W. Britt and J. W. Eastes presented data on the effect that synthetic resins have on the internal bonding of paper and the modifications of existing test methods which may be needed in order to obtain reliable test data for these materials.

A recent development in paper making is a type of paper having fabric-like properties. Such nonwoven fabrics can thus enter fields formerly open only to textile materials. Among the factors discussed by J. T. Taylor and P. J. McLaughlin is the softness or stiffness of the nonwoven fabric. The authors presented a cantilever test as a proposed measure of the flexural rigidity of these paper fabrics.

F. H. Koontz and J. K. Owens showed that the present methods of paper testing are inadequate for synthetic fiber papers; modifications are necessary for the tongue-tear test and the Elmendorf tear tester, as well as other standard tests. The authors report on results of chemical resistance, expansivity, bursting strength, fold endurance, and porosity measurements of synthetic papers.

Hydroxyethylated cotton linters are providing the paper industry with a new furnish which will improve the characteristics of finished paper. J. A. Harpham showed that the identification of these fibers cannot be accomplished by the standard Herzberg iodine stain technique. He pointed out that microscopical study of fiber morphology and polariscopic examination of the unswollen fibers is necessary for complete identification of this new furnish.

R. J. Diaz reviewed the testing program used to evaluate the characteristics of a new paper in which a large amount of carefully controlled machine direction stretch is built into the paper.

The development of machines for the production of continuous paper knitted products was presented by R. H. Marks. This development indicates that test procedures peculiar to the textile industry will soon be utilized by the fabricators of knit paper.

Textiles

Difficulties of Obtaining and Interpreting Data

A disturbing amount of data is obtained under circumstances which make adequate observations imperfect or impossible, according to Prof. E. R. Schwarz, head of the Textile Division, Massachusetts Institute of Technology, speaking at the Session on Textiles. Discussing the principles and methods of experimental design, he explained how to cope with the difficulties of acquiring reliable data under complex or obscure situations. He stated that it is seldom possible when working with laboratory equipment to do more than estimate intervals in time or space to the nearest half scale division. If intervals are changed, then the length and spacing of intervals, starting points, and end points, must be estimated. He stressed the importance of the trained observer in testing and research.

The utilization of data once acquired was then discussed in a paper on "Difficulties with Data," by Kenneth R. Fox and Richard D. Wells, Fabric Research Laboratories, Inc. The authors pointed out that whereas data gathering is the science of "quantifying" qualitative factors for purposes of description, analysis, computation, and comparison, interpretation is the art of relating quantitative description back to qualitative meanings. Decisions are never made "quantitatively" but rather always in accordance with subjective qualitative considerations. Any data to be practically useful as a basis for decision must be converted or translated into nontechnical terms. In testing and in most experimental work the final judgment is on considerations of desirability. In the conclusion to their paper, the authors urged that organizations such as the ASTM devote, in the future, as much attention to the interpretation and utilization of data as they have to standardization of data-gathering procedures, keeping in mind that "knowledge of materials" precedes specifications and methods of testing.

Instrumentation

Adaptations for Air Pollution Measurement

An instrument, developed at the University of California in Berkeley, is capable both of counting aerosol particles and of measuring the size to a lower limit of 0.3 μ using light scattering. This instrument, which is being used by the Los Angeles Air Pollution Foundation for measurement of both solid and liquid particles in the air, was described by Chester T. O'Konski of the University of California. The instrument, while quite useful, is not specific and does not differentiate between different kinds of aerosols. To obtain more complete information it is necessary to supplement the data with other methods such as light and electron microscopy, and chemical analysis.

Prof. O'Konski's paper was one of four presented at an informal symposium on instrumentation, held at the Annual Meeting and sponsored by Committee D-22 on Methods of Atmospheric Sampling and Analysis. Lewis A. Rogers of the Los Angeles Air Pollution Foundation compared the relative merits of gas chromatography, colorimetry, and spectrometry for air pollution measurements. He pointed out that photochemical smog has extremely dynamic characteristics that are hard to follow. For this reason, instrument methods capable of very rapid determinations are quite useful in following these reactions. Long-path infrared has certain advantages as determined by an instrument developed at the Franklin Institute. A similar instrument is being built by Perkin Elmer which will have 40 one-meter passes using gold-coated reflectors, each reflecting about 0.98 of the incident infrared energy. Gas-liquid partition chro-

matography is also proving to be particularly advantageous in air pollution measurements according to Mr. Rogers.

M. D. Thomas of Stanford Research Inst. described a recorder for atmospheric fluorides occurring as HF. The recorder measures in the range of 1 to 3 parts per billion and is based upon the reduction in fluorescence caused by HF when a magnesium salt of 8-hydroxyquinoline is exposed to radiation of 3650 Å.

Morris Katz of Canada's Department of Health and Welfare described current methods for evaluation of aerosol contaminants by filtration. By these methods the aerosols are caught on a special filter and either weighed, evaluated photoelectrically, or otherwise analyzed.

Radioactivity in Industrial Water

New problems in the field of water technology associated with the development of nuclear power were the subject of the symposium sponsored by Committee D-19 on Industrial Water. In this symposium, problems in the reactor plant proper were discussed, the associated waste water processing and control methods were described, and methods of analysis for radionuclides in industrial water and industrial waste water were presented, including discussion of attendant radiation hazards. Also covered were the effects of nuclear operations on the environment and analysis of samples. The scope of the symposium was purposely made broad enough to provide background information as to the conditions associated with the new phases of work on industrial water and industrial waste water into which the committee is now moving actively.

Purity of primary water must be at levels well beyond those previously required in order to minimize build-up of radioactivity and because of much greater problems of maintenance in the presence of radioactivity. It therefore becomes necessary to analyze for constituents in extremely low amounts, even smaller than parts per billion, for radioactive elements, for elements that change rapidly or disappear with time. Accordingly a whole new set of procedures for sampling and analysis must be developed. These problems are discussed. Also covered are methods for determining whether radiation hazards in water conform to standards for allowable limits.

In the processing of industrial wastes, one encounters a whole new set of problems. Precise analytical and control methods are required in order to evaluate the type and amount of by-products that are being released and the rate of their release. Careful analysis of environmental samples is necessary in order that background levels of radioactivity and other contamination may be accurately known and not confused with further contamination being discharged.

Extensive discussion was evidence of strong interest in the symposium and will add to the value of the published material.

Annual Meeting Papers Still Available

SOME of the papers which were not preprinted for the 1958 Annual Meeting were mimeographed primarily for the use of those interested in presenting discussion. A limited number of these are available from ASTM Headquarters, 1916 Race St., at a charge of 50 cents each.

A Machine for the Evaluation of High-Temperature Alloys Under Combined Static and Dynamic Stresses by P. E. Hawkes and C. H. Ek

Stress-Rupture and Creep Properties of Malleable Iron at Elevated Temperatures by L. C. Marshall and G. F. Sommer

Some Factors Affecting Durability of Structural Clay Product Masonry by P. V. Johnson and H. C. Plummer

Relation Between Actual and Artificial Weathering by F. W. Reinhart

The Durability of Buildings by R. F. Legget and N. B. Hutcheon

Studies in Ore Car and Abrasive Grain Sampling Variation by R. S. Bingham, Jr., J. L. Gioele, and V. B. Shelburne

Reflectance Tests for Concrete Curing Materials by C. C. Rhodes, M. H. Janson, and M. G. Brown

Extending Concrete High Durability with Silicones by H. L. Cahn and R. V. Mackey, Jr.

Dosimetry Techniques for Gamma and Reactor Radiation Fields by Paul Schall, Jr. and J. F. Kircher

The Engineering Test Reactor as an Irradiation Facility by R. L. Doan

A Facility for the Study of the Effects of Nuclear Radiation on Materials by J. L. Colp and A. W. Snyder

Some Observations on the Effects of High Neutron and Gamma Fluxes on the Transmission Characteristics of Some Optical Glasses by J. L. Colp and H. N. Woodall

Objective Appraisal of Stripping of Asphalt from Aggregate by A. B. Brown, J. W. Sparks, and G. E. Marsh

Field Experience and Laboratory Study of Slow-Setting Paving Grade Asphalt in Airfield Pavement Construction by D. D. Fenton

Field Observations of the Behavior of Bituminous Pavements as Influenced by Moisture by W. K. Parr

Relationship of Aggregate Characteristics to the Effect of Water on Bituminous Paving Mixtures by J. M. Rice

Effect of Additives by P. V. Critz

Methods of Testing for Water Resistance of Bituminous Paving Mixtures by W. H. Goetz

A Fundamental Charpy Impact Transition Temperature by C. E. Hartbower and G. M. Orner

Fracture Strengths Relative to Onset and Arrest of Crack Propagation by G. R. Irwin, J. A. Kies, and H. L. Smith

Correlation of Tests Using the Congruency Principle by J. D. Lubahn

Prediction of Long-Time Creep with Ten-Year Creep Data on Four Plastic Laminates by W. N. Findley and D. B. Peterson

A High Damping Magnesium Alloy for Missile Applications by G. F. Weissmann and W. Babington

A Study of the Variability in the Mechanical Properties of Grade A Phosphor Bronze Strip by M. N. Torrey, G. R. Gohn, and M. B. Wilk

Shear Strength and Elastic Properties of Soil-Cement Mixtures Under Triaxial Loading by G. G. Balmer

Soil Moisture Suction—Its Importance and Measurement by E. Penner

The Mechanical Behavior of Chemically Treated Granular Soils by R. L. Schiffman and C. R. Wilson

Measurement of Soil Pressure on a Laterally Loaded Pile by Hudson Matlock and E. A. Ripperger

Specific Gravity of Montmorillonite Clay Constituents by J. C. Shea

Compressibility of Sands by J. E. Roberts and J. M. deSouza

A Review of the API Committee on Analytical Research Subcommittee on Measurement of Physical Properties of Cracking Catalysts by L. L. Mittelman

New Methods for Determining Particle Size Distribution by Examining Gravitational and Centrifugal Sedimentation by Soren Berg

A Discussion of the Recommended Practice of Reporting Particle Size Characteristics of Pigments (ASTM Tentative Method D 1366 – 55 T) by J. H. Calbeck

A Study of the Blaine Fineness Tester. Calculation of Surface Area from Air Permeability Data by S. S. Ober and K. J. Frederick

Three-Dimensional Electronic Sizing of Sub-Sieve Particles at 6000 per Second by R. H. Berg

Some Historical Developments in Paper Testing by W. R. Willets and F. R. Marchetti

Non-Woven Fabrics and Synthetic Fiber Papers: Technology and End Uses by J. T. Taylor and P. J. McLaughlin

Testing of Synthetic Fiber Papers by F. H. Koontz and J. K. Owens

Investigation of Banded Sediments Along St. Lawrence-North Shore in Quebec by R. W. J. Pryer and K. B. Woods

Soil Classification Scheme Based on Compaction Tests by J. L. McRae

The Value of Soil Test Data in Local and Regional Road Planning by Martin Ekse

Radioactivity and Purity Control of APPR Primary Water by A. L. Medin

Radioactive Waste Processing and Control at the Shippingport Atomic Power Station by S. F. Whirl and J. A. Tash

The Analysis of Environmental Samples for Radionuclides by D. L. Reid

Radiation Effects on Materials

Notable advances in design of nuclear reactors and increased irradiation facilities were highlights of the third symposium on Radiation Effects on Materials, sponsored jointly by the Atomic Industrial Forum and ASTM Committee E-10 on Radioisotopes and Radiation Effects.

The Sandia Engineering Reactor Facility is unique in that it has a radiation room directly under the reactor proper in which large pieces of machinery can be irradiated. Space is also provided for pre- and post-irradiation testing. The Engineering Test Reactor (ETR) in Idaho has nine major irradiation facilities, ranging from one that is 9 in. square to four that are 3 in. square, incorporated directly in the reactor core. The Canadian research reactor (NRU) at Chalk River is designed for high heat output and easy replacement of irradiated materials without interrupting reactor operation. An in-pile fatigue testing apparatus designed at Syracuse University makes it possible to conduct fatigue tests within a nuclear reactor under controlled strain, frequency, temperature, and environment.

Of interest to the electronics and communications industries are results of studies conducted by Admiral Corp. and reported by A. F. Donovan on the effects of nuclear radiation on natural quartz piezoelectric crystals used in control of radio frequencies.

Effects of radiation on several types of optical glass were reported by J. L. Colp of the Sandia Corp.

Others on the program were from Atomic Power Development Associates, General Electric Co., Atomics International, and Argonne National Laboratory; they dealt with the effects of radiation on component parts, fuel elements, fuel materials, and control materials. N. Balai of Argonne National Laboratory discussed the problems facing the designer of reactor pressure vessels for nuclear application.

Particle Size

Electroformed Precision Sieves Offer Advantages

The Symposium on Particle Size Measurement brought up to date the developments in instrumentation and technology that have taken place since the 1941 ASTM Symposium on New Methods for Particle Size Determination in the Sub-Sieve Range.

In spite of the importance of sieving as a means of size analysis and as an industrial separation process, there have been few attempts to elucidate the laws that govern the sieving process. In a paper on "The Mechanics of Fine Sieving" K. T. Whitby, Assistant Professor of Mechanical Engineering, University of Minnesota, presented a study which endeavored to derive and prove the physical laws which govern the sieving of fine particulates through conventional sieves with conventional equipment.

One of the most interesting papers in the symposium described the more recently developed electroformed precision micromesh sieves for the determination of particle size. This paper on "Application of Electroformed Precision Micromesh Sieves to the Determination of Particle Size Distribution of Cracking Catalysts," by H. W. Daeschner, E. E. Seibert, and E. D. Peters, Shell Development Co., Emeryville, Calif., described a variety of problems that confront the petroleum refiners who try to use woven-wire sieves for determining particle size distribution of cracking catalysts. The authors indicate that not only are the sieves limited in the lower range to 44 microns but they are inherently unreliable. The strongly entrenched popularity of the sieving procedure, resulting from its simplicity, prompted these authors to investigate this new process made by electroforming nickel in meshes of precise square openings ranging from 15 to 105 microns. Satisfactory micromesh sieves were developed and details of procedures for use established. These micromesh sieves are recommended as a primary standard for testing size distribution of cracking catalysts because of their highly precise openings, which can be reliably measured with a microscope.

Electroformed sieves were also used in another study of fluid cracking catalysts made by the API Committee on Analytical Research. A review of the work of this committee was presented in a paper by Louis Mittelman, Tidewater Oil Co. Fluid cracking catalysts include both naturally occurring clays and synthetically manufactured substances. They are prepared and used as finely-divided bulk mixtures with particle sizes ranging downward from a usual maximum diameter of approximately 100 microns.

Research workers in the fine particle field often spend weeks or months preparing samples of particulate material for their research. The material may have special characteristics with respect to particle size, size distribution, density, and other properties. A large part of the sample preparation involves determining the properties of the sample. When a particular investigation is concluded, the samples may be of no further use to the man who prepared them but may be of considerable use to others working in the fine particle field. Early in 1956, the Stanford Research Inst. established a Particle Bank to serve as a depository for such samples and to make them available to any investigator who might need them.

The paper by R. D. Cadle and W. Thuman describes the types of material that are available from this Particle Bank. Judging from the activity of the bank, it has filled a real need in the fine particle field and it is expected that its usefulness will increase as it becomes better known and a larger supply of samples is accumulated.

Other papers in the 3-session symposium were concerned with sedimentation, turbidimetric, and electronic methods.

Tax Deduction Incurred in Society Activities

The following information will no doubt be useful to some ASTM members who may not get all their society expenses reimbursed.

"The Internal Revenue Service under ruling 55-4 I.R.B. 1955-1 states that a taxpayer who gives his services gratuitously to an association, contributions to which are deductible under the relevant provisions of the Code and who incurs unreimbursed traveling expenses, including the cost of meals and lodging, while away from home in connection with the affairs of the association and at its direction, may deduct the amount of such unreimbursed expenses in computing his net income; subject, however, to the limitation in respect to all gifts made to exempt organizations of this type; namely, that the total amount of such gifts made in any one year may not exceed 20 per cent of the donor's gross income for such year. This limitation means that while such expenses are deductible, they are included with other gifts in computing the 20 per cent limitation."

New Officers

President Woods

Vice-President Bates

Kenneth B. Woods

Kenneth B. Woods has been head of the School of Civil Engineering and director of the Joint Highway Research Project at Purdue University, Lafayette, Ind., since July 1, 1954. In addition to his academic work, he is well known throughout civil engineering circles for his work in engineering research and as a consultant to Canadian and U. S. Government agencies and to railroad and other industrial concerns dealing with the location, design, and construction of air fields, railroads, and highways in Alaska, Canada, and the United States.

Professor Woods is a native of Sunnyside, Wash. He was educated at Ohio State University where he received the degree of Bachelor of Civil Engineering in 1932 and the Professional Degree of Civil Engineer in 1937.

He began his association with Purdue University in 1939 as assistant professor of highway engineering. He was also appointed assistant director of the Joint Highway Research Project the same year, becoming associate director in 1945. In 1945 he was presented the Highway Research Board award for a paper of outstanding merit on highway materials and in 1949 received the distinguished service award of the Highway Research Board. He was elected chairman of the board's executive committee in 1956 and the same year was named chairman of the advisory committee of the American Association of State Highway Officials with a $21,000,000 road test program at Ottawa, Ill.

Professor Woods has a long record of active service in ASTM. He is chairman of committee D-4 on Road and Paving Materials; a member of Committee D-18 on Soils for Engineering Purposes; a member of Committee C-9 on Concrete and Concrete Aggregates (chairman 1946–1952); and served on the Administrative Committee on Papers and Publications for a number of years. He was elected a director of the Society in 1953 and vice-president in 1956.

Memberships in other societies include American Society of Civil Engineers, The Association of Asphalt Paving Technologists, American Road Builders' Assn., American Concrete Inst., The Society of American Military Engineers, The American Society for Engineering Education, U. S. Council on Soil Mechanics and Foundation Engineering, American Railroad Engineering Assn., and others. He has served as a member of the Flood Control and Water Resources Committee of the State of Indiana since 1954.

He is a member of Triangle Fraternity, Chi Epsilon, Sigma Xi, and Tau Beta Pi.

A. Allan Bates

A. Allan Bates has been vice-president for research and development of the Portland Cement Assn, Chicago, since 1946. He joined the PCA after ten years as manager of Chemical, Ceramic, and Metallurgical Research at Westinghouse Electric Corp.

A native of Elyria, Ohio, Dr. Bates was graduated from Ohio Wesleyan University with an A.B. degree in 1923. Case Institute of Technology conferred on him the degree of B.S. in Metallurgical Engineering in 1925 and M.S. in engineering in 1929. He received the Doctor of Science degree in 1931 at the University of Nancy, France. Stevens Institute of Technology awarded him the honorary degree of Doctor of Engineering in 1944 and Rose Polytechnic Institute the honorary degree of Doctor of Science in 1947. He served as professor of metallurgical engineering for two periods at Case School of Applied Science, 1927 to 1929 and 1932 to 1937. During World War II, he served on special missions for the State Department in South America and later for the U. S. Army in Europe.

Dr. Bates has been a member of ASTM since 1946 and of the ASTM

Paul A. Archibald, Director

William L. Fink, Director

Board of Directors since 1955. He has been active in ASTM work for many years as representative of the Portland Cement Assn. on Committee C-1 on Cement and as a member of Committee E-10 on Radioisotopes and Radiation Effects. As chairman of the C-1 Subcommittee on the Cement Reference Laboratory, he has taken an especially active part in developing the operations of the CRL which involve the coordinated interests of many private and governmental groups and agencies interested in testing cements and concretes. He is also a member of the American Chemical Society; American Ceramic Society; American Society for Metals; the American Institute of Mining, Metallurgical, and Petroleum Engineers; American Society of Civil Engineers; American Concrete Institute (of which he has served as a director), Sigma Xi; and Tau Beta Pi.

Paul A. Archibald

Paul A. Archibald, chief metallurgist at Standard Steel Works, Burnham, Pa., was educated at Massachusetts Institute of Technology and Colorado School of Mines, receiving the degree of Metallurgical Engineer in 1935. After graduation, he was employed by the U. S. Steel Corp. in the Open-Hearth Department and Metallurgical Laboratory at South Chicago. In 1937 he became metallurgist with the Denver, Rio Grande & Western Railroad where he assisted in organizing the Rio Grande Research Laboratory. He has been with Standard Steel Works Division of Baldwin-Lima-Hamilton since 1941, except for active duty as a Major, Corps of Engineers, U. S. Army, 1942–1945. He became chief metallurgist in 1949.

Mr. Archibald is a member of Committee A-1 on Steel and serves on numerous subcommittees, having first become active in ASTM committee work in 1939.

He is also a member of The American Society of Mechanical Engineers, American Society for Metals, American Iron and Steel Inst., British Iron and Steel Inst., Steel Founders' Society of America, American Ordnance Assn., Acid Open-Hearth Research Assn., Forging Manufacturers' Association, and the Department of Defense Metallurgical Advisory Committeee on Guns.

William L. Fink

William LaVilla Fink has been chief of the Physical Metallurgy Division of the Alcoa Research Laboratories since 1943. He is a native of Indiana and an alumnus of the University of Michigan, where he was awarded his Ph.D. degree in Chemistry in 1926. Since graduation Dr. Fink has worked in the Research Laboratories of the Aluminum Company of America where his work has been principally in the fields of alloy structure, alloy development, improvement in metallurgical practices, X-ray diffraction, corrosion, and nondestructive testing.

Dr. Fink has been a member of ASTM Committee E-4 on Metallography since 1931. He has served on several of the subcommittees and has been chairman of Subcommittee VI on X-ray Methods since 1937. He took an active part in the formation of the joint committee on X-ray diffraction data and has been active in this work up to the present time, serving as chairman of the technical Policy Subcommittee. In recent years he has been active in Subcommittee VI on Ultrasonic Testing Procedures of Committee E-7 on Nondestructive Testing, serving as chairman of the project group for the establishment of ultrasonic standard reference blocks, and chairman of the project group for the standardization of ultrasonic instruments and transducers.

He has written or contributed to many scientific papers, holds several patents, and has presented numerous talks at conventions and other meetings. Dr. Fink is a recognized authority on the subjects of aluminum alloy phase diagrams, metallurgical changes during heat-treatment, corrosion, X-ray techniques, and nondestructive testing.

He is also a member of the American Society for the Advancement of Science; American Institute of Mining, Metallurgical, and Petroleum Engineers; American Society for Metals; American Chemical Society; American Ordnance Assn.; American Crystallographic Assn.; Society for Nondestructive Testing; and the British Institute of Metals.

Harry M. Hancock

Harry Morrison Hancock is manager of the Product Control Department of The Atlantic Refining Co., Philadelphia.

He was graduated from the University of Pennsylvania in chemical engineering in 1919, and in 1928 received the degree of Chemical Engineer.

Mr. Hancock has worked for The Atlantic Refining Co. from the time of his graduation, first in the Research and Development Department and later in the Manufacturing Department, before becoming manager of the Product Control Department.

He has been a member of ASTM since 1924. His activities have been largely in the work of Committee D-2 on Petroleum Products and Lubricants on which he has served as chairman of a number of Research and Technical Divisions and is presently chairman of the Research Division on Color. He was the first chairman of the Philadelphia District Council and has served on Committees D-1 on Paint, Varnish, Lacquer, and Related Products; D-15 on Engine Antifreezes; D-9 on Electrical Insulating Materials, and others.

Mr. Hancock is also a member of the American Petroleum Inst. and the Philadelphia Engineers' Club.

Lawrence A. O'Leary

Lawrence A. O'Leary, head, Chemical Engineering and Research Dept. of W. P. Fuller and Co., was graduated

Harry M. Hancock, Director

Lawrence A. O'Leary, Director

Alfred C. Webber, Director

from North Dakota State College in 1929 and was granted the degree of Ph.D. in physical chemistry in 1933 from the University of Notre Dame.

He was an instructor in chemistry at Loyola University in Los Angeles for one year and joined the staff of W. P. Fuller & Co. in 1935, holding various positions in the Industrial Finishes, Chemical Engineering, Research, and currently the Latex Finishes Divisions of the General Laboratory.

Dr. O'Leary was an officer in the Army Chemical Corps 1941–1946 and holds the rank of lieutenant colonel in the U. S. Army Reserve.

His activities in ASTM include his current membership on Committee D-1 on Paint, Varnish, Lacquer and Related Products; Northern California District Council; and the Administrative Committee on District Activities.

He is a member of the American Institute of Chemical Engineers, American Chemical Society, Federation of Paint and Varnish Production Clubs, and the American Association for the Advancement of Science.

Alfred C. Webber

Born in Lisbon Falls, Me., Alfred Chester Webber received his B.S. degree *cum laude* from Bates College, Lewiston, Me., and his M.S. in Physics from Boston University. From 1928 to 1942, Mr. Webber was instructor of science in Franklin, Mass., and instructor of physics in the Brookline, Mass., high schools.

He joined du Pont in 1942 at the Arlington, N. J., Plastics Laboratory, now part of the Polychemicals Department, and was appointed research supervisor in 1946. He went to the Experimental Station in 1950 when the Plastics Laboratory was moved to that location. In 1957, Mr. Webber became senior supervisor, his present position, and continues his work in the field of physical measurements on polymers and plastics, including national and international standardization, as well as departmental coordination of physical test methods.

Mr. Webber has been active in ASTM committee work since 1945 and is presently chairman of Committee E-1 on Methods of Testing, vice-chairman of Committee D-20 on Plastics, and a member of Committee C-19 on Structural Sandwich Constructions. He is also a member of the American Group for the International Standards Organization Technical Committee on Plastics and attended several meetings of the ISO held in Europe in 1957.

Honorary Members

The Society's Highest Honor

An Honorary Member is a person of widely recognized eminence in some part of the field which the Society covers or one who has rendered especially meritorious service to the Society. He is elected only by unanimous vote of the Board of Directors on a letter ballot.

Herbert J. Ball

Truman S. Fuller

Herbert J. Ball

Herbert J. Ball, former professor of textile engineering at the Lowell Institute of Technology, was graduated from Massachusetts Institute of Technology in 1906 with the S.B. degree in Mechanical Engineering and joined the faculty of Lowell Technological Inst. in that same year. He was head of the Textile Engineering Department and later chairman of the Division of Engineering at the Institute. Professor Ball served as acting president of the Institute for several months in 1945–1946 during the absence of the then president Kenneth R. Fox. He retired in 1955 after 49 years of continuous service.

Professor Ball has been active in the affairs of the ASTM since 1929. He served as a member of the Board of Directors (then known as the Executive Committee), vice-president, and president of the Society and on various other committees of the organization. In 1930 he was elected chairman of Committee D-13 on Textile Materials and held this office for 20 years. In March, 1953, he was awarded the Harold DeWitt Smith medal in recognition of his outstanding services to this group.

Professor Ball served as a delegate to a meeting of the Textile Committee of the International Standards Organization in Buxton, England, in 1948. He then went to France for the International Silk Congress as a delegate from the United States, and was later initiated as a member of the XLIII Chapitre des Chevaliers du Tastevin. He is currently chairman of the Administrative Committee on End-Use Products and a member of the New England District Council of ASTM.

In addition to his engineering degrees, he was graduated from Northeastern University School of Commerce and Finance in 1916 with honors in professional accountancy and for many years taught these subjects in addition to his engineering courses. He is the author of several technical papers, pamphlets, and bulletins. A Fellow and Chartered Textile Technologist of the British Textile Inst., he also holds membership in The American Society of Mechanical Engineers, the American Society for Quality Control, the American Society for Engineering Education, the Textile Research Inst., and was an original member of the U. S. Institute for Textile Research. In June, 1957, he was awarded an Honorary Doctor of Science degree by the Lowell Technological Institute.

James G. Morrow

J. L. McCloud

Truman S. Fuller

Truman S. Fuller, a native of Saratoga Springs, N. Y., formerly engineer in charge of the Works Laboratory, General Electric Co., and currently metallurgical consultant, was graduated with a B.S. in Chemistry from Syracuse University in 1911. He joined the General Electric Co. as a chemist at the Edison Lamp Works, Harrison, N. J. Later he was transferred to the General Electric Research Laboratory in Schenectady as metallurgist. In 1938 he entered the Works Laboratory as engineer of materials and five years later became assistant engineer of that division.

Mr. Fuller was appointed engineer in charge of the Works Laboratory in 1945 and continued in that position until his retirement in 1953. Since that time he has acted as metallurgical consultant. With General Electric, his attention was early directed toward the endurance of metals in moist air and steam. Properties of metals at high temperature and the embrittlement of copper also engaged his attention; as one of the original members of the G.E. "Creep Committee" he laid the foundation of what is now called creep-rupture testing, but the work at Schenectady has been extraordinarily diverse, ranging from cemented carbides to die castings to copper to turbine alloys.

Mr. Fuller joined the ASTM in 1926. He has twice served as a member of the Board of Directors from 1939 to 1941, (when it was known as the Executive Committee) from 1947 to 1950. He was president of the Society in 1951–1952. In addition to his activities in ASTM, he holds membership in the American Society for Metals; the American Institute of Mining, Metallurgical, and Petroleum Engineers; and the British Institute of Metals.

J. L. McCloud

John Lansford McCloud formerly manager of manufacturing research of the Staff Manufacturing Engineering Office of the Ford Motor Co. and currently a consulting editor of *Metal Progress*, is a native of Detroit, Mich., and a graduate of the University of Michigan (Bachelor of Chemical Engineering, 1913). He was employed by the Ford Motor Co. from 1915 until his retirement in 1956. Beginning as a chemist, he later was placed in charge of chemical and metallurgical research at the Dearborn Tractor Plant. At the Rouge Plant he became, successively, assistant in charge of the laboratories, director of chemical and Metallurgical Research and Control Department, manager of manufacturing research of the Staff Manufacturing Engineering Office, and staff consultant in the foregoing office. During his years at Ford Motor Co., his principal interests were metallurgy, coatings (especially paint), and petroleum products (especially lubricants). He was the patentee of an alloy of chromium and silicon used for valves and was the originator of zinc chromate primers for aluminum structures.

Mr. McCloud's ASTM activities include service on Committees A-5 on Corrosion of Iron and Steel and D-2 on Petroleum Products and Lubricants (26 years on the latter); former member of the Board of Directors, honorary member of the Detroit District Council of which he had served as secretary and chairman.

He is a member of the American Chemical Society, American Society for Metals (life member), and the Engineering Society of Detroit and was also a member of the Society of Automotive Engineers, Institute of Metals, Society of Chemical Industry, American Institute of Chemical Engineers, and the American Electroplaters Society.

James G. Morrow

James Garfield Morrow, metallurgical engineer, Steel Company of Canada, Ltd., was born in Hamilton, Ont., and received his early education at Central Collegiate Inst. He began his work at the Steel Company of Canada, Ltd., as assistant chemist, becoming successively chief night chemist, inspecting engineer, and metallurgical engineer.

Mr. Morrow's technical associations have been varied. In 1917 he became a member of the Canadian Standards Association and was appointed chairman, which post he held until 1936. He is now a director and chairman of a number of its committees. He worked for many years to bring about unification of techniques with Britain, the United States, and Canada and saw this achieved when the Declaration of Accord on Screw Threads was signed in 1948.

During World War II he was known for the development of "Morrow" steel and was technical advisor to the Government Steel Controllers. In recognition for the latter, he was made a Member of the British Empire (M.B.E.) in the King's birthday honor list, 1943. He has been active too in the development of iron ore mining in Canada; and he was largely responsible for the organization of the Canadian Ordnance Assn., later the Canadian Industrial Preparedness Assn., of which he was a director and is now president.

Mr. Morrow has been active continuously in the ASTM since 1911, serving on various committees. He is presently a member of Committees A-1 on Steel, E-4 on Metallography, B-1 on Wires for Electrical Conductors, and A-3 on Cast Iron. He served as president of the Society in 1949–1950.

His activities in other societies have included the American Iron and Steel Inst., Society of Automotive Engineers, American Wire Assn., Association of Professional Engineers of Ontario, and the Canadian Institute of Mining and Metallurgy. In 1955 he was awarded the Standards Medal, sponsored jointly by the American Standards Association and the National Bureau of Standards. It was the first time this award had been made to a Canadian.

Awards of Merit

O. P. Beckwith

T. I. Coe

R. H. Heilman

Twelve leaders in the field of engineering materials—men who have rendered outstanding service to the American Society for Testing Materials, particularly in its technical committee work—were honored at the President's Luncheon of the Annual Meeting with Awards of Merit.

Under the rules governing the Award of Merit, each technical committee may suggest one candidate annually, and the Award Committee may select nominees from other areas of the Society's work as well. While each of the men listed below was honored for intensive work and contributions in a specific technology, each has furthered in numerous ways the general activities of the Society.

To **Oliver P. Beckwith,** *quality control director, The William Carter Co., Needham Heights, Mass., in recognition of outstanding service and contributions as secretary of Committee E-11 on Quality Control of Materials, and for constructive work in Committee D-13 on Textile Materials.*

Mr. Beckwith is a native of Yonkers, New York, and received his degree in Mechanical Engineering from New York University.

He has been active in ASTM affairs since 1939.

Following graduation from New York University, he worked in the Standards Department of Swift & Co. In 1935, he joined Alexander Smith Corp., carpet manufacturers, and was associated with this company until 1953, with the exception of a one-year period he served with the Office of the Quartermaster General as principal textile technologist, Military Planning Division, Research and Development Branch, Textiles Section, Washington, D. C. At the Alexander Smith Corp., he started as development engineer and before leaving the company was director of quality control. From 1954 to 1956 he was senior research Associate of the Fabric Research Laboratories, Inc., Dedham, Mass.

Mr. Beckwith is a Fellow of the American Society for Quality Control and is a registered professional engineer in the state of New York.

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To **Theodore Irving Coe,** *technical secretary, American Institute of Architects, Washington, D. C., in recognition of long-time, very faithful service and leadership in technical committee work, especially Committees C-12 on Mortars for Unit Masonry, C-15 on Manufactured Masonry Units, and C-18 on Natural Building Stones.*

Mr. Coe is a native of Waterbury, Conn. He has a long and distinguished career in architecture. He supervised construction of the Hotel St. Regis in New York City for the Trowbridge & Livingston Co. For nine years he was associated with Howells & Stokes, Architects, New York City. He served as chief inspector of the Bureau of Fire Prevention for the City of New York. During the construction of the United States Supreme Court Building from 1932–1935, he represented the architectural firm associated with its construction. Since 1935 he has been associated with the American Institute of Architects.

Mr. Coe is a Fellow of the American Institute of Architects and recipient of the Edward C. Kemper Award made each year by the AIA to the member who has made the most significant contribution to the Institute and to the profession during that time. Since 1936, he has served on ASTM Committee C-18 on Natural Building Stones and is currently vice-chairman. He is past president of the New Rochelle, N. Y., Art Association; life member of the Connecticut Society of Civil Engineers; life member of the Engineers Club of New York City; chairman of the Washington, D. C., Board of Zoning Adjustment; first president of the Washington Building Congress; honorary member of the Producer's Council, Inc., and recipient of their award of recognition; past chief commander and life member of the United States Power Squadrons; member of the Cosmos Club and numerous other professional and learned societies.

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To **Russell Howard Heilman,** *senior industrial fellow, Mellon Institute of Industrial Research, Pittsburgh, Pa., in recognition of important, outstanding contributions to the work of Committee C-16 on Thermal Insulating Materials since its organization in 1938, especially in heat transfer and water vapor transfer.*

Mr. Heilman received his B.S. degree from the University of Pittsburgh in 1921. He received a degree in Electrical Engineering in 1923 and Mechanical Engineering in 1927 from the same University.

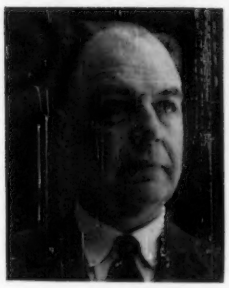
He has been extremely active in ASTM activities since 1929. Formerly a member of ASTM Committee C-8 on Refractories, he served as chairman of several subcommittees. He was a charter member of ASTM Committee C-16 on Thermal In-

J. B. Rather

A. H. Scott

B. F. Scribner

C. P. Larrabee



F. V. Lenel

J. J. Moran

sulating Materials and served as vice-chairman as well as chairman of various subcommittees. He served on the Joint Committee on Thermal Conductivity of all Forms of Insulation sponsored by ASHVE, ASRE, NRC, and ASTM. In addition to his work on Committee C-16 he is also a member of ASTM Committee E-6 on Methods of Testing Building Constructions.

Mr. Heilman is a member of The American Society of Mechanical Engineers, American Society of Heating and Air Conditioning Engineers, and is a registered professional engineer in the State of Pennsylvania. He is a member of the Sectional Committee on Letter Symbols for Heat and Thermodynamics and is the author of some 30 papers on heat insulation and heat transfer.

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To **Clifford P. Larrabee,** *research technologist at the Applied Research Laboratory, United States Steel Corp., Monroeville, Pa., in recognition of valued and sustained participation in ASTM work involving the corrosion and deterioration of metals, especially in the corrosion committees, A-5 (Iron and Steel) and B-3 (Non-Ferrous Metals).*

Mr. Larrabee is a graduate of the University of Maine, where he received a B.S. in chemical engineering.

He joined the Chemistry Division of the National Bureau of Standards and served with this organization for 10 years before becoming a member of the staff of the Applied Research Laboratory of the United States Steel Corp.

Since 1935, he has been concerned with research work on the corrosion of steel products, particularly in the areas of atmosphere and other natural media exposures.

Mr. Larrabee has been active in ASTM affairs since 1945 and has served on Committees A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys; A-5 on Corrosion of Iron and Steel; B-3 on Corrosion of Non-Ferrous Metals and Alloys; B-8 on Electrodeposited Metallic Coatings; and D-1 on Paint, Varnish, Lacquer and Related Products.

Mr. Larrabee has presented many lectures on various phases of corrosion and is the author of numerous publications on the subject. In addition to his ASTM affiliation, he is a member of numerous scientific and technical societies.

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To **Fritz V. Lenel,** *professor, Department of Metallurgical Engineering, Rensselaer Polytechnic Institute, Troy, N. Y., in recognition of constructive, energetic efforts in the development of practical standards, and for leadership in the work of Committee B-9 on Metal Powders and Metal Powder Products.*

Dr. Lenel received his Ph.D. degree from the University of Heidelberg, Germany, in 1931. He did postgraduate work at the University of Goettingen from 1931 to 1933.

He joined the staff of Charles Hardy, Inc., New York City, as a metallurgist in 1933 and remained with that organization until 1937 when he became associated with the Moraine Products Division of the General Motors Corp., Dayton, Ohio, as a metallurgist. Here he worked on research and development and production control in the powder metallurgy of self lubricating and engine bearings, filters, and structural parts. Since 1947, he has been a member of the staff of the Rensselaer Polytechnic Institute where he has conducted work on powder metallurgy in connection with projects sponsored by government and industry. Some of his research has been directed toward cemented carbides, liquid phase sintering, aluminum powder metallurgy, and porous metals and alloys for transpiration cooling. He is supervisor of Powder Metallurgy Research and director of the Powder Metallurgy Laboratory in the Department of Metallurgical Engineering.

Dr. Lenel has been a member of ASTM Committee B-9 on Metal Powders since its inception in 1944. He has served as secretary of the committee and chairman as well. In addition to his ASTM activities, Dr. Lenel is a member of Sigma Xi, Phi Lambda Upsilon, The American Society for Metals, American Society for Engineering Education, and is a past chairman of the Powder Metallurgy Committee of the American Institute of Mining, Metallurgical, and Petroleum Engineers.

In 1955 he was the Gillett Memorial Lecturer. He is the author of numerous publications. Among the more important of these are: "Porous Stainless Steel Compacts for Transpiration Cooling," "Sintering with a Liquid Phase," "Pole Pieces for Electric Motors Made from Iron Powder," and "Oil Pump Gears an Example of Iron Powder Metallurgy."

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To **James J. Moran,** *technical manager, Sales Department, Kimble Glass Co., Subsidiary Owens-Illinois Glass Co., Vineland, N. J., in recognition of intensive, consistent activity in ASTM district and technical work, especially notable on instruments and laboratory glassware and in Committee E-1 on Methods of Testing.*

Mr. Moran is a graduate of the University of Pennsylvania with a degree of B. S. in chemical engineering. He has been associated with the Kimble Glass Co. since 1920.

During most of this time, Mr. Moran has been concerned with glass laboratory apparatus, including all phases of manufacturing, advertising, and selling. At the present time, Mr. Moran is technical director for the Scientific Sales Division. In this capacity, he is responsible for the specifications for all the laboratory glass

M. A. Swayze

L. J. Trostel

V. P. Weaver

apparatus made by his company. As part of his duties he works with the manufacturing departments to see that processes are kept up to date.

Mr. Moran has been active in ASTM work since 1935. He is a member of Committees D-2 on Petroleum Products and Lubricants and E-15 on Engine Antifreezes. In addition, he serves on six subcommittees of Committee E-1 on Methods of Testing which are concerned primarily with laboratory apparatus. Mr. Moran is also a councilor of ASTM Philadelphia District.

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To **James B. Rather, Jr.,** *assistant director, Technical Service Department, Socony Mobil Co., Inc., Brooklyn, N. Y., in recognition of marked leadership and contributions to many of the activities of Committee D-2 on Petroleum Products and Lubricants, especially the committee on gasoline, and for support of ASTM administrative work.*

Mr. Rather is a native of Bryan, Tex. He received the degree of B.S. in chemical engineering from Lehigh University in 1932 and attended the Harvard Graduate School of Business Administration from 1932–1933. He first entered the petroleum industry in 1933 as a process engineer for Max B. Miller & Co., Inc.

In February, 1935, he accepted a position with the Magnolia Petroleum Co., an affiliate of Socony Mobil Oil Co., Inc., at their refinery in Beaumont, Tex. In 1937 he was made assistant chief chemist, and later that year was transferred to the Technical Service Laboratory of Socony's Research Department, in Brooklyn, N.Y. He has served in various supervisory positions including assistant supervisor of the Lubricants Section, supervisor of the Engineering Section, and supervisor of the Inspection Division.

Mr. Rather has been active in ASTM Committee D-2 on Petroleum Products and Lubricants, since 1945 and presently serves on many of its subordinate committees. He is vice-chairman of Technical Committee A on Gasoline, chairman of Research Division VI on Analysis of Lubricants, and chairman of Section F on Tetraethyllead of Research Division III.

Mr. Rather served as chairman of the Committee on Analytical Research of the American Petroleum Institute, Division of Refining, from 1948 to 1950, and has been active in the affairs of that committee since its inception in 1946. He has served on the Administrative Committee on Standards of ASTM since 1956.

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To **Arnold Henry Scott,** *physicist, National Bureau of Standards, Washington 25, D. C., in recognition of intelligent leadership and unfailing energy supporting the activities of Committee D-9 on Electrical Insulating Materials, advancing the standing of the Society nationally and internationally in this area.*

Dr. Scott is a native of Iowa. He received his B.S. degree from the University of Mississippi in 1921 and his M.S. degree in 1923.

In 1924 he accepted a position as junior physicist at the National Bureau of Standards and has remained with the Bureau since that time. He obtained his Ph.D. in Physics from John Hopkins University in 1928.

Dr. Scott joined the American Society for Testing Materials in 1945 and has been an active member of Committee D-9 on Electrical Insulating Materials, serving as chairman for six years. He is currently chairman of Subcommittee V on Ceramic Products. He has been chairman of ASA Sectional Committee C59 on Electrical Insulating Materials since 1949. In addition, he is technical adviser to the United States National Committee on matters pertaining to the work of TC 15 of the International Electrotechnical Commission and has four times been a United States Delegate to the meetings of the IEC.

Dr. Scott is a member of the Washington Academy of Sciences, the New York Academy of Sciences, the American Institute of Electrical Engineers, and the Philosophical Society of Washington. He is a Fellow of the American Association for the Advancement of Science and the American Physical Society.

To **Bourdon Francis Scribner,** *chief of Spectrochemical Section, National Bureau of Standards, Washington, D. C., in recognition of distinguished leadership and service as an officer for 16 years of Committee E-2 on Emission Spectroscopy, and outstanding contributions in publishing Methods for Emission Spectrochemical Analysis and the notable indices to the literature.*

Mr. Scribner, a native of Westernport, Md., received his B.S. in chemistry from the George Washington University in 1933, and his M.S. in physical chemistry from the University of Maryland in 1939. He entered the Spectroscopy Section of the National Bureau of Standards in 1927 and in the period 1942–1947 he supervised a group under the Manhattan Project in developing and applying spectrochemical methods to the analysis of uranium and related materials. In 1947 he was appointed chief of the Bureau's newly-formed Spectrochemistry Section of the Chemistry Division.

Mr. Scribner has been active in ASTM as a committee member since 1936, and as a member of the Society since 1949. He served as secretary of Committee E-2 on Emission Spectroscopy from 1936 to 1948, and as chairman of the committee from 1946 to 1954. He is co-author of several Society publications and has been a member of Committees E-13 on Absorption Spectroscopy and D-22 on Methods of Atmospheric Sampling and Analysis.

An active member of the American Chemical Society since 1934, he has held several offices in the Washington Section, ACS, including those of secretary in 1955 and chairman in 1957, and served as associate editor, 1952–1953, and editor, 1954–1955, of "The Capital Chemist."

In addition to the ASTM, Mr. Scribner is a member of the American Chemical Society, American Association for the Advancement of Science, Instrument Society of America, Washington Academy of Sciences, and Optical Society of America. He is an author of 39 publications in basic and applied spectroscopy.

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To **Myron Allan Swayze,** *director of research, Lone Star Cement Corp., New York, N. Y., in recognition of long-time, valued service and support of ASTM administrative and technical activities, especially for constructive contributions to the work of Committee C-1 on Cement.*

Mr. Swayze is a native of Lima, N. Y. He received his B.S. degree from the Case Institute of Technology in 1912 and a degree in chemical engineering in 1921 from the same institute.

Joining the Lone Star Cement Corp. in 1913, he became assistant chief chemist of the Dallas Mill. He has held successive positions as chief chemist for the

Thank You, New England

In expressing thanks to the General Committee on Arrangements for the Boston Meeting, to its chairman, Miles N. Clair, and his hardworking group of subcommittee chairmen and members, certain facts are incontrovertible—a new high record of attendance, the very large outpouring of ladies and their full participation in the fine program arranged by Mrs. Miles N. Clair working with the Entertainment Committee, the more than two thousand friends at the Boston Pops Concert, and, finally, the very large number of compliments heard at the meeting—these should give the committee great gratification.

The Board of Directors, speaking for all those at the meeting and the whole Society is deeply grateful to New England for the wonderful job it did in every respect in acting as the host for this momentous 61st Annual Meeting.

Houston Mill; chief chemist for the Hudson, N. Y., Mill; and assistant chief chemist for the Lone Star Cement System. In 1934 he became the director of research for the Lone Star Cement Corp. In 1945, he made a survey of German cement industrial capacity for the Foreign Economic Administration.

Mr. Swayze has been active in ASTM since 1925. He served as a director for two terms, from 1939–1941 and from 1952–1955. He has been a member of ASTM Committee C-1 on Cement since 1930 and has served as chairman of several of its subcommittees.

In addition to ASTM activities, Mr. Swayze is active in the American Petroleum Institute, Portland Cement Association, and the American Concrete Institute. He was a director of ACI for two periods, 1944–1945, and 1948–1950. He is the recipient of the Wason Medal for noteworthy research, granted by the ACI.

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To **Louis Jacob Trostel,** *manager of research laboratories, General Refractories Co., Baltimore, Md., in recognition of long-time, constructive efforts and leadership in the work of Committee C-8 on Refractories where he served as Secretary, and for support of administrative work of the Society.*

Mr. Trostel is a native of Ohio. He received his B. S. degree in chemical engineering from Ohio State University and subsequently professional degrees of Chemical Engineer and Ceramic Engineer.

His early professional career as engineer with the U. S. Bureau of Mines and U. S. Bureau of Chemistry engaged him in studies of hazardous industrial gases and dusts. For the past 35 years he has been associated with the research department of the General Refractories Co. and is presently the manager o their research laboratories.

Mr. Trostel has been active in the affairs of ASTM since 1925. He has served as an officer of Committee C-8 on Refractories and is currently secretary of that committee. He has served as director of the Society 1947–1950; and as chairman of the Award of Merit Committee in 1952.

He is the author or coauthor of some 30 papers and patents on industrial gases and dusts as well as the physical chemistry, application, and evaluation of refractory materials.

• • •

To **Vincent P. Weaver,** *metallurgical engineer, The American Brass Co., Waterbury, Conn., in recognition of outstanding administrative and technical competence as secretary of Committee B-5 on Copper and Copper Alloys for twelve years, and for valued contributions to ASTM from a vast experience in this field.*

Mr. Weaver, a native of Torrington, Conn., received his B.S. in metallurgy from Yale University in 1927.

Since graduation he has been employed in the Technical Department of The American Brass Co., where he now holds the position of Metallurgical Engineer.

Mr. Weaver has been active in ASTM since 1944 when he became a member of Committee B-5 on Copper and Copper Alloys, as a representative of his company. He has been active on many subcommittees and served as secretary from 1944 to 1956. Mr. Weaver is also a member of Committees B-1 on Wires for Electrical Conductors, B-2 on Non-Ferrous Metals and Alloys, B-7 on Light Metals and Alloys, E-4 on Metallography, and the Joint Committee on Welding Fittings of the ASTM Nonferrous Coordinating Committee.

He has been a member of the Supervisory Group to the American Standards Assn. in administering the secretariat of ISO-26 on Copper and Copper Alloys, a technical committee of the International Organization for Standardization. In 1955 he was one of two delegates who represented ASA at the first meeting of ISO-26 at Stockholm, Sweden, where he served as secretary of the committee sessions.

In addition to his ASTM committee affiliations, Mr. Weaver is also a member of the American Institute of Mining and Metallurgical Engineers, the Subcommittee on Nonferrous Materials of the American Society of Mechanical Engineers Boilers and Pressure Vessel Committee, two committees on copper and copper alloys for revising the Metals Handbook of the American Society for Metals, Nonferrous Metals Technical Committee of the Society of Automotive Engineers and the American Petroleum Institute manufacturers' Subcommittee on Heat Exchanger Tubing. He was a member of the Business and Defense Services Administration Copper Division Committee on Nickel Conservation during 1954 and 1955 and has also served on the Copper and Brass Research Assn. Alloy Data subcommittee.

Mr. Weaver has written or contributed to, numerous technical articles on the properties of copper and copper alloys.

Display of ASTM publications at the Tool Show sponsored by the American Society of Tool Engineers in Convention Hall, Philadelphia, May 1 to 8.

The space was made available to the Society through the courtesy of the American Society of Tool Engineers and was manned throughout the show by members of the Philadelphia District Council and the ASTM Staff. More than 31,000 tool engineers attended the show, many of them stopping at the ASTM exhibit and showing a keen interest in the Society's work.

ASTE is a nonprofit, engineering society with 38,000 members throughout the United States and Canada. It has numerous chapters in American manufacturing centers and maintains its headquarters in Detroit.

Medals and Awards

Original Research in Engineering Materials

J. E. Dorn

T. A. Trozera

O. D. Sherby

CHARLES B. DUDLEY MEDAL

This medal, established by voluntary subscriptions from the members, is a means of stimulating research in materials and of recognizing meritorious contributions to its publications, at the same time commemorating the first president of the Society, whose inspiring leadership has had a profound influence on its development.

● 1958 award to **John E. Dorn, Thomas A. Trozera,** and **Oleg D. Sherby** for their paper entitled, "The Effects of Creep Stress Histories at High Temperatures on the Creep of Aluminum Alloys," given at the 1956 Annual Meeting of the Society.

John E. Dorn, professor of physical metallurgy, University of California, is a native of Chicago, Ill. He received his B.A. in chemistry from Northwestern University in 1931; and his master's degree in 1932 from the same school. In 1936, he received a Ph.D. in physical chemistry from the University of Minnesota. Following a postdoctoral Research Fellowship at Battelle Memorial Institute, he joined the faculty of the University of California in 1938 as an assistant professor of chemical engineering. He served as a research metallurgist with the Dow Chemical Co. in 1941, returning to his post at the University of California in 1942. Mr. Dorn is a member of ASTM Committee E-9 on Fatigue. He is a recipient of the Joint Army-Navy Award for outstanding research during World War II, and is the author or co-author of 90 publications in physical metallurgy, engineering, physical chemistry, and organic chemistry.

Thomas A. Trozera is a native of California and received his B.S. in mechanical engineering (*cum laude*) from the University of California, Berkeley, in 1953 and his master's degree in 1955. He will receive a Ph.D. in physical metallurgy from the University of California in September, 1958. Since 1956, he has served as coordinator of the Cooperative Engineering Program, College of Engineering, University of California, Berkeley. He studied under the Bechtel Corporation Scholarship Award, 1952–1953 and held a General Electric Predoctoral Fellowship 1954–1956, at the University of California.

Oleg D. Sherby, scientific liaison officer, London, England, U. S. Office of Naval Research, is a native of Shanghai, China, and is now a naturalized U. S. citizen. He was a James Monroe MacDonald Scholar at the University of California and received his B.S., M.S., and Ph.D. in physical metallurgy from that University. While working for his Ph.D. from 1950 to 1956, he was a research engineer for a project sponsored by the Office of Naval Research at the University. He is the author or co-author of 25 publications.

Industrial Water

F. R. Owens

MAX HECHT AWARD

This award, in honor of the first chairman of Committee D-19 on Industrial Water is presented to a member of that committee in recognition of outstanding service to the committee in the advancement of its objective—the study of water as an engineering material.

● 1958 award to **F. R. Owens.**

F. R. Owens, president, Cyrus William Rice & Company, Pittsburgh, Pa., is a native of Indiana. He received his B.S. in chemical engineering from Rose Polytechnic Institute in 1921. He was awarded his M.S. in 1926, and his doctorate in 1948. He started his industrial career with the Duquesne Light Co., Pittsburgh, Pa., as a laboratory testing engineer. He became assistant chief chemist in 1924. In 1927 he joined Cyrus William Rice & Co. in Pittsburgh as a chemical engineeer. He was elected secretary of the company in 1929 and president in 1952. Since 1942, Dr. Owens has been a member of ASTM. For a number of years he served as chairman of Subcommittee III of Committee D-19 on the Methods of Sampling Industrial Water. He was elected vice-chairman of Committee D-19 in 1950 and has continued in this capacity to date. He is the author or co-author of a number of technical papers, including "Silica Deposits in Steam Turbines" (1946), "Influence of Copper with Respect to Corrosion in Boilers" (1940), "Boiler Water Conditioning for High Pressure Boilers" (1939).

Testing of Soils

D. M. Burmister

C. A. HOGENTOGLER AWARD

This award was established by Committee D-18 on Soils to commemorate its first chairman, to be given to authors of outstanding papers on soils presented at a meeting of the Society.

● 1958 award to **Donald M. Burmister** for his paper entitled, "Environmental Testing of Soils," presented at the 1956 ASTM Annual Meeting.

Professor Burmister, professor of civil engineering, Columbia University, is a native of Arizona and studied at Columbia University, receiving his B.A. in 1926; his B.S. in 1927; and Ph.D. in 1938. He joined the faculty of Columbia University in 1929. He has been active on ASTM Committee D-18 on Soils since 1937, and is the author of numerous publications and papers, including contributions to ASTM special technical publications, proceedings and BULLETIN articles. He has been a consulting foundation engineer on many noteworthy projects, including the New York World's Fair, structures in the Brooklyn Navy Yard, the White House reconstruction, the New York Thruway crossing of the Hudson River, and the Narrows Bridge in New York.

Corrosion Research and Tests

W. G. Renshaw

R. A. Lula

SAM TOUR AWARD

The purpose of this award is to encourage research on the improvements and evaluation of corrosion testing methods and to stimulate the preparation of technical papers in this field.

● 1958 award to **W. G. Renshaw and R. A. Lula** for their paper on "The Corrosion Properties of Chromium-Nickel-Manganese Austenitic Stainless Steel."

W. G. Renshaw, Research and Development Laboratories, Allegheny Ludlum Steel Corp., is a graduate of Pennsylvania State University with a B.S. in chemical engineering. He has been associated with the Allegheny Ludlum Steel Corp. since his graduation, with the exception of two years served with the United States Navy. He has been engaged in corrosion work for many years and is the author of several papers on stainless steel and titanium. Since 1956, he has been a member of ASTM Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys.

R. A. Lula, chief research metallurgist, Stainless Steel Section, Allegheny Ludlum Steel Corp. Research and Development Laboratories, is a graduate of the University of Bucharest and Carnegie Institute of Technology. He received degrees in metallurgy from both schools and has been associated with the Allegheny Ludlum Corp. since 1950. Since 1955, he has been a member of ASTM Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys. He is the author of several papers on stainless steels.

Concrete and Aggregates

C. E. Kesler

T. S. Chang

SANFORD E. THOMPSON AWARD

This award was established by Committee C-9 on Concrete and Concrete Aggregates to commemorate its first chairman, to be given to the authors of papers of outstanding merit in that field, to stimulate research and extension of knowledge, and to recognize meritorious efforts.

● 1958 award to **Clyde E. Kesler** and **Tien S. Chang** for their paper "Correlation of Sonic Properties of Concrete with Creep and Relaxation," presented at the 1956 Annual Meeting.

Clyde E. Kesler, professor of theoretical and applied mechanics, University of Illinois, is a native of Dewey, Ill.. He received his B.S. from the University of Illinois in 1943 and M.S. in 1946 from the same university. In 1946 he joined the Illinois Central Railroad as an engineering aide. In the following year he joined the University of Illinois. He has been active in ASTM since 1949 and is a member of Committee C-9 on Concrete and Concrete Aggregates and several of its subcommittees.

Tien S. Chang, associate professor of applied mechanics, Virginia Polytechnic Institute, is a graduate of the University of Illinois. While at the University he was engaged in fundamental research for structural dynamics and rheological behavior of viscoelastic materials. He is actively engaged in research for the design of supersonic compressors and the sonic properties of nonlinear viscoelastic materials. He has been a member of ASTM since 1956.

Test Methods and Apparatus

A. F. Robertson

Daniel Gross

J. J. Loftus

RICHARD L. TEMPLIN AWARD

The purpose of this award is to stimulate research in the development of testing methods and apparatus, to encourage the presentation to the Society of papers describing new and useful testing procedures and apparatus, and to recognize meritorious efforts of this kind.

● 1958 award to **A. F. Robertson, Daniel Gross,** and **Joseph J. Loftus,** for their paper, "A Method for Measuring Surface Flammability of Materials Using a Radiant Energy Source" presented at the 1956 Annual Meeting of the Society.

A. F. Robertson is a graduate of the University of Wisconsin. He received his B.S. in 1935 and his doctorate in 1940. He has been with the National Bureau of Standards since 1950 where he has been largely responsible for the direction of research studies relating to accidental fires. Currently chief of the Fire Protection Section of the Bureau, he is also chairman of Subcommittee X of ASTM Committee E-5 on Fire Tests of Materials and Construction. He has been active on this committee since 1955.

Daniel Gross received his Bachelor of Mechanical Engineering degree from Cooper Union School of Engineering in 1949 and was a research assistant at Columbia University prior to joining the National Bureau of Standards in 1950. His work has included investigations of heat transfer, ignition, and flame spread properties of materials.

Joseph J. Loftus received his B.S. in chemistry from the University of Scranton in 1951 and joined the Electrochemistry Section of the National Bureau of Standards the following year. In the Fire Protection Section for the past four years, he has worked on the development of a test method for evaluating the flame spread characteristics of materials.

New Tentatives and Standards

1958 Output Reflects Industry Growth

AT THE 61st Annual Meeting the Society accepted 113 new tentative specifications and methods of test, the titles and designations of which are given below, with brief notes on their significance. Other actions taken at the meeting in regard to standards are summarized in the box.

The numerical designations of the technical committees responsible for these tentatives are shown after the boldface headings.

STEEL (A-1)

Specifications for:

Uncoated Stress-Relieved Wire for Prestressed Concrete (A 421 – 58 T)

The steadily increasing use of prestressed concrete has resulted in a great need for industry wide standards governing the production and purchase of the steel cable and wire used for prestressing. Last year the Tentative Specification for Uncoated Seven-Wire Stress-Relieved Strand for Prestressed Concrete was published to cover the cable. The steel wire is covered in the present specification. Two types of wire are included, one intended for anchoring by cold end deformation and the other for anchoring by wedges.

Butt Welds in Still Tubes (A 422 – 58 T)

Applications for still tubes sometimes necessitate the use of lengths longer than those normally produced on mills. This is accomplished by butt welding. To standardize the practice so that uniform properties could be obtained, this specification was developed by Committee A-1.

Seamless and Electric Welded Low Alloy Steel Tubes for Economizers (A 423 – 58 T)

Various low alloy steel compositions afford better corrosion resistance than the ordinary carbon steels. It has been found advisable to use these in the form of steel tubes for pressure-containing parts such as economizers or other applications where corrosion resistance is important.

Specification for:

Steel Sheets for Porcelain Enameling (A 424 – 58 T)

ASTM Committee C-22 on Porcelain Enamel requested Committee A-1 to develop these specifications. Both commercial quality sheet for bending or moderate forming and drawing quality sheet for producing severely drawn identified parts within established breakage allowances are included.

Hot-Rolled Carbon Steel Strip, Commercial Quality (A 425 – 58 T)

Committee A-1 has been revising and realigning its specifications covering sheet and strip steel. These specifications represent an extension of the present coverage to include a product which is widely used.

Centrifugally Cast Ferritic Alloy Steel Pipe for High-Temperature Service (A 426 – 58 T)

Applications of this pipe in service installations have yielded data used as a basis for these specifications. Oil refineries were particularly interested in having industry-wide specifications developed.

Factory-Made Wrought Carbon Steel and Alloy Steel Welding Fittings of Seamless or Welded Construction for Low-Temperature Service (A 420 – 58 T)

Publication of these specifications is a natural development as a result of the existence of ASTM specifications for steel plate, pipe, tube, bolting, castings, and forgings for low temperature service.

Wrought Alloy Steel Rolls for Cold and Hot Reduction (A 427 – 58 T)

Experience in the production and purchase of alloy steel rolls to be used in the manufacture of flat rolled ferrous and non-ferrous products has indicated the need for these specifications. In view of the wide variety of requirements, this specification is the type that points out the items which should be considered when manufacturing and purchasing such rolls.

CORROSION OF IRON AND STEEL (A-5)

Methods of Test for:

Weight of Coating on Aluminum-Coated Iron or Steel Articles (A 428 – 58 T)

This method is the first standard to be published for hot-dipped aluminum coatings which have, in the last few years, appeared in increasing volume as corrosion resistant structural materials. The committee is currently working on a specification which will be supported by this new test method.

MAGNETIC PROPERTIES (A-6)

Methods of Test for:

Alternating-Current Magnetic Properties of Laminated Core Specimens (A 346 – 58).

These new standard methods cover the determination of core loss, exciting current, a-c permeability, and related properties of flat-rolled magnetic materials when tested in lamination stacks or other core forms. They fall into three principal categories: bridge method for tests at low and moderate inductions (10 to 10,000 gausses); bridge method for core loss and exciting current tests at 10 kilogausses, 50 or 60 cycles per sec; and voltmeter-ammeter method for tests at inductions of 10 gausses to inductions where the excitation is about 50 rms ampere turns per in. of magnetic path.

Alternating-Current Magnetic Properties of Epstein Specimens (A 343 – 58)

These extensively revised methods cover the determination of core loss, exciting current, a-c permeability, and related properties of flat-rolled magnetic materials with either normal or incremental magnetization when tested as Epstein specimens. They fall into three principal categories: wattmeter method for tests at moderate and high inductions (up to 18 kilogausses), bridge method for tests at low and moderate inductions (10 to 10,000 gausses), and bridge method for core loss tests at 10 kilogausses and higher, 50 or 60 cycles per sec.

Both the above methods are supplementary to Methods of Testing Magnetic Materials (A 34 – 55).

CORROSION RESISTING STEELS (A-10)

Specifications for:

Hot-Rolled and Cold-Finished Corrosion-Resisting Chromium-Nickel-Manganese Steel Bars (A 429 – 58 T)

As a nickel conservation measure, types 201 and 202 stainless steels were developed by the American Iron and Steel Institute. ASTM Specifications A 412 – 57 T cover these steels in the form of plate, sheet, and strip. The present specifications will extend the coverage to steel bars.

WIRES FOR ELECTRICAL CONDUCTORS (B-1)

Specifications for:

Half-Hard Aluminum Wire for Electrical Purposes (B 323 – 58 T)

Last year the Underwriters' Laboratories expanded the range of tensile strength permitted for intermediate temper aluminum wire from 17,000 to 22,000 psi, to a new 15,000 to 22,000 psi range. This was done because some users preferred a more ductile wire for smaller size building wires whereas other users preferred the stronger temper for larger cables for duct and conduit installation. Accordingly the new specification is recommended to supplement the present Specification B 262 for three-quarter-hard wire.

Rectangular and Square Bare Aluminum Wire for Electrical Conductors (B 324 – 58 T)

During the last few years there has been growing commercial interest in rectangular and square aluminum wire for use as magnet wire. About three years ago the committee noted the trend and started to develop suitable specification requirements, as part of its continuing program of developing specifications for several particular types of aluminum conductors.

ACTIONS ON STANDARDS—ANNUAL MEETINGS

	1958	1957	1956	1955	1954
Proposed Methods Published as Information	21	33	22	22	22
New Standards	2	0	0	0	0
New Tentatives	**113**	**99**	**83**	**65**	**65**
Revision of Tentatives	158	142	121	161	118
Tentative Revision of Standards	16	15	14	18	25
Revision of Standards and Reversion to Tentative	22	18	13	27	18
Reversion of Standards to Tentative, No Revision	2	0	0	0	0
Adoption of Tentatives as Standard Without Revision	116	52	124	92	108
Adoption of Tentatives as Standard With Revision	19	12			
Adoption of Tentative Revisions as Standard	13	9	14	18	10
Revision of Standards, Immediate Adoption	154	79	75	141	27
Withdrawal of Standards	15	3	10	15	7
Withdrawal of Tentatives	6	8			
Withdrawal of Tentative Revisions of Standards	1	1	0	0	0

MISCELLANEOUS NON-FERROUS METALS AND ALLOYS (B-2)

Specifications for:

Refined Secondary Lead (B 325 – 58 T)

Under development for several years, the obtaining of almost unanimous agreement on these specifications must be considered as a very important accomplishment by Committee B-2. The specifications cover lead in pig form made from scrap by processes of smelting and refining. The two types covered are designated soft lead and copper bearing lead.

METALLIC MATERIALS FOR ELECTRICAL HEATING, ELECTRICAL RESISTANCE, AND ELECTRICAL CONTACTS (B-4)

Method of Test for:

Resistance Characteristics of Microcontacts (B 326 – 58 T)

This test applies to electrical contact materials used in make-and-break circuits. It outlines a procedure for measuring contact resistance of materials tested at maximum current of 100 ma and a maximum force of 5 g. To evaluate contact materials the test is run repeatedly and the change in contact conductivity noted.

LIGHT METALS AND ALLOYS (B-7)

Specifications for:

Aluminum Alloy Hardeners Used in Making Zinc-Base Die Casting Alloys (B 327 – 58 T)

To produce zinc base alloys used in die castings, hardeners are added to special high grade zinc purchased in accordance with ASTM Specifications B 6. Three such hardeners are provided in the present specifications, as well as their proportionate mixture with special high grade zinc to produce the die casting alloys.

ELECTRODEPOSITED METALLIC COATINGS (B-8)

Recommended Practice for:

Cleaning Metals Prior to Electroplating (B 322 – 58 T)

This recommended practice describes the procedure for cleaning metal surfaces to obtain good adhesion of electrodeposited metals. Since the cleanliness required for metal to be electroplated is of a higher order than for most other applications, the committee has developed this method to cover the general aspects of this type of cleaning.

METAL POWDERS AND PRODUCTS (B-9)

Methods of Test for:

Density and Interconnected Porosity of Sintered Powder Metal Structural Parts and Oil Impregnated Bearings (B 328 – 58 T)

These tests were formerly a part of each individual specification for metal powder structural parts. They were deleted from the product specifications and printed as a separate document. Appropriate reference is now contained in the product specifications.

Average Particle Size of Refractory Metals and Compounds by the Fisher Subsieve Sizer (B 330 – 58 T)

Apparent Density of Refractory Metals and Compounds by the Scott Volumeter (B 329 – 58 T)

Since its recent organization the section on refractory metal powders of ASTM Committee B-9 has been very active. These two methods represent the first two areas of standardized tests which are necessary in reaching any specification requirements.

Determination of the Compressibility of Metal Powders (B 331 – 58 T)

This is another in a series of tests developed by the section on base metal powders of Committee B-9 leading toward the eventual publication of specification requirements. Other published tests include apparent density, flow, sieve analysis, subsieve analysis, and green strength of unsintered compacted specimens.

CHEMICAL-RESISTANT MORTARS (C-3)

Methods of Test for:

Working and Initial Setting Times of Chemically-Setting, Silicate Type Chemical-Resistant Mortars (C 414 – 58 T)

This method provides a standard procedure for determining working and initial setting times of silicate-type only chemical-resistant mortars. The test results, in respect to working time, greatly assist the applicator in knowing the time interval from the start of mixing during which the mortar may be applied to a brick or tile surface without curling behind the trowel. The determination of initial setting time is for the interval in hours from the start of the mixing to the time when a Gillmore needle will penetrate the mortar to a certain depth within a certain time.

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Absorption and Apparent Porosity of Chemical-Resistant Mortars (C 413 – 58 T)

This method provides a procedure for determining the absorption and apparent porosity of three types of chemical resistant mortars, namely, silicate, resin, and sulfur types.

LIME (C-7)

Specification for:

Quicklime and Hydrated Lime for Sand-Lime (C 415 – 58 T)

This specification provides requirements as to chemical composition and physical properties for quicklime and hydrated lime suitable for use in the manufacture of sand-lime products. It is the latest addition to a series of specifications for lime as used for specific purposes and products other than as a plaster or a mortar.

REFRACTORIES (C-8)

Method of Test for:

Thermal Conductivity of Castable Refractories (C 417 – 58 T)

This method was developed to supplement the Method of Test for Thermal Conductivity of Refractories (C 201), specifically for determining the conductivity of castable refractories.

Classifications of:

Silica Refractory Brick (C 416 – 58 T)

This method is a further step toward enlarging the list of classifications for commercially produced refractories.

Fireclay and High-Alumina Refractories (C 27 – 58 T)

This classification is a revision of the Standard Classification of Fireclay Refractory Brick which has been enlarged to include commercially produced high-alumina brick.

CONCRETE (C-9)

Method of Test for:

Abrasion Resistance of Concrete (C 418 – 58 T)

The abrasion resistance characteristics of concrete are determined by this method involving shot-blast apparatus which subjects the concrete to the impingement of air-

SUMMARY OF ACTIONS TAKEN AT 1958 ANNUAL MEETING AFFECTING STANDARDS AND TENTATIVES.

	New Standards and Existing Tentatives Adopted as Standard	Standards in Which Revisions Will Be Adopted	New Tentatives	Revisions of Standard and Reversions to Tentative	Tentative Revisions of Standards	Tentatives Revised	Standards Tentatives Withdrawn
A. Ferrous Metals—Steel, Cast Iron, Wrought Iron, Alloys, etc.	16	19	10	3	1	43	3
B. Non-Ferrous Metals—Copper, Zinc, Lead, Aluminum, Alloys, etc.	14	52	10	...	...	37	...
C. Cement, Lime, Gypsum, Concrete and Clay Products	19	22	13	4	3	18	...
D. Paints, Petroleum Products, Bituminous Materials, Paper, Textiles, Plastics, Rubber, Soap, Water, etc.	72	71	71	13	12	55	13
E. Miscellaneous Subjects, Testing, etc	16	3	8	2	...	4	5
F. Electronic Materials	...	...	1	...	...	1	...
Total	137	167	113	22	16	158	21

driven silica sand or steel grit. The method is not intended for use in specifications, but as a basis for research in the development of information.

THERMAL INSULATION (C-16)

Methods of Test for:

Mechanical Stability of Preformed Thermal Insulation by Tumbling (C 421 – 58 T)

The method covers a procedure for determining the mechanical stability of preformed thermal insulation as indicated by its resistance to a combination of abrasion and impact produced by a laboratory tumbling mechanism. No single test method in the past has completely covered all factors involving these forces for different kinds of insulation. It may be used for comparing the resistance to tumbling before and after a specific treatment of the insulation.

Making and Curing Test Specimens of Mastic Thermal Insulation Coatings (C 419 – 58 T)

This new tentative standardizes the procedure for making and curing of test specimens of all types of mastic thermal insulation coatings.

Thermal Conductivity of Insulating Materials at Low Temperatures by Means of the Wilkes Calorimeter (C 420 – 58 T)

The heat transmitted through a material is influenced by, among other factors, the density and structure of the material, the temperature gradient and the mean temperature, and any moisture that is present within the material. Using the Wilkes low-temperature calorimeter, thermal conductivity values are determined for insulating materials having conductivities not in excess of 1.0 Btu in. per hr sq ft deg Fahr.

NATURAL BUILDING STONES (C-18)

Specification for:

Structural Granite (C 422 – 58 T)

This specification is the second of two such specifications covering natural building stones which have been presented to the Society and represent the first attempt on the part of anyone to develop a national standard based on physical requirements and characteristics of a particular building stone. The physical requirements are first divided into two ranges; less than 50 years and more than 50 years of life expectancy. In addition, there are two grades of use, engineering and architectural, with a number of specific uses being listed for each grade having corresponding requirements in minimum compressive strength and maximum percentage of wear.

ACOUSTICAL MATERIALS (C-20)

Method of Test for:

Sound Absorption of Acoustical Materials in Reverberation Rooms (C 423 – 58 T)

A reverberation room is a highly sound-reflective room in which special care has been taken to make the sound field as diffuse as possible. This method of test describes how a reverberation room is used to measure the sound absorption coefficients of acoustical materials. The materials being tested may be in the form of a plane surface such as acoustical ceiling or wall treatment, or may be separate objects such as theater chairs or space absorbers.

CERAMIC WHITEWARE AND RELATED PRODUCTS (C-21)

Method of Test for:

Crazing Resistance of Fire Glazed Whitewares by Autoclave Treatment (C 424 – 58 T)

As part of a program to standardize methods which are currently used by the industry, this autoclave method is being published as recommended by the committee.

PAINT, VARNISH, LACQUER (D-1)

Specifications for:

Distilled Linseed Fatty Acids (D 1537 – 58 T)

These specifications cover two types of fatty acids produced by the distillation of linseed oil. Type I is usually produced from whole linseed oil and referred to as water white linseed fatty acids. Type II is usually produced from recovered linseed oil and is referred to as regular distilled linseed fatty acids.

Distilled Soybean Fatty Acids (D 1538 – 58 T)

These specifications cover three types of fatty acids produced by the distillation of soybean oil. Type I is usually produced from whole soybean oil and referred to as water white soybean fatty acids. Types II and III are usually produced from recovered soybean oil.

Dehydrated Castor Acids (D 1539 – 58 T)

These specifications cover two types of acids produced from dehydrated castor oil. Type I is a distilled dehydrated castor acid, and Type II is an undistilled dehydrated castor acid.

Methods of Test for:

Effect of Staining Agents on Organic Finishes Used in the Transportation Industry (D 1540 – 58 T)

In this method the test surface is placed in contact with a staining agent suspected of having a deleterious effect. The choice of staining agent is governed by ultimate coating use, and by agreement between the purchaser and the seller of the finish being tested. The method lists a number of staining agents that are of general interest. This method is a companion standard to the Method of Test for Effect of Household Chemicals on Clear and Pigmented Organic Finishes (D 1308 – 57).

Total Iodine Value (D 1541 – 58 T)

This method is applicable to oils, fatty acids, and bodied oils. The total iodine value is a measure of the total unsaturation present in fats and oils, expressed as the number of centigrams of iodine equivalent to the unsaturation present in 1 g of sample.

Color Change of White Architectural Enamels (D 1543 – 58 T)

This method describes a procedure for empirically evaluating the color change in white architectural enamels subjected to a discoloring atmosphere. Home atmospheres and environments may cause similar discoloration.

Color of Transparent Liquids (Gardner Color Scale) (D 1544 – 58 T)

This method specifies 18 Gardner reference standard color solutions for use in evaluating the color of transparent liquids. The evaluation is made by the comparison of the sample with the reference standard color solutions in Gardner-Holt viscosity tubes. The comparison is made at 25 ± 5 C by placing the tubes close together and looking through them against a background which is substantially equal in color to the northern sky.

Viscosity by Bubble Time Method (D 1545 – 58 T)

This method determines the viscosity in bubble seconds by timing or comparison. The bubble seconds are approximately equal to stokes. It is applicable to transparent liquids which are free from crystalline or gel particles. The viscosity of a liquid by this method is defined by the resistance experienced by one portion of a liquid moving over another portion of the liquid.

Performance Tests of Clear Floor Sealers (D 1546 – 58 T)

This method covers a procedure for testing clear floor sealers for appearance of finish, treatment of worn areas, the application of finishing materials such as varnish, liquid or paste waxes, either solvent or emulsion type, and resistance to ink staining.

Qualitative Tests for Rosin in Varnishes (D 1542 – 58 T)

This method covers procedures for the qualitative detection of rosin in varnishes by the Lieberman-Storch Test, and the Halphen-Hicks Test. The rosin may be present as either free rosin (abietic acid), esterified rosin, or as metal salts.

PETROLEUM PRODUCTS (D-2)

Tables:

ASTM Butadiene Measurement Tables (D 1550 – 58 T)

These tables are for use in the calculation of quantities of butadiene. They cover the normal operating ranges for the reduction of specific gravity and volume to 60/60 F and for the calculation of weight-volume relationships of butadiene. They are applicable to both butadiene and butadiene concentrates (minimum of 60 per cent butadiene). These measurement tables replace those in the National Bureau of Standards *Letter Circulars LC-736* and *LC-757*, and the Rubber Reserve Co. *Butadiene Laboratory Manual*. Included in the D-2 Report as information, there appears in a separate appendix the formulas and coefficients used in computing these butadiene measurement tables.

Methods of Test for:

Zinc in New Lubricating Oils and Lubricating Oil Additives (Polarographic Method (D 1549 – 58 T)

This method describes a polarographic procedure for the determination of zinc in new lubricating oils and lubricating oil additives containing no more than 2 per cent zinc. Since cadmium is used as pilot ion, this metal interferes and must be absent from the sample.

Vanadium in Navy Special Fuel Oil (D 1548 – 58 T)

In this method fuel oil is treated with concentrated sulfuric acid and the mixture reduced to acid-free coke and then dry ashed at 525 C. Mixed acids are added to the inorganic ash and the residue reduced to sulfuric acid fumes. Phosphoric acid and sodium tungstate are added, and vanadium is determined by measuring the absorbance of its phosphotungstovanadic acid complex at 436 mμ. The vanadium concentration is obtained from the absorbance by means of a previously prepared calibration curve.

Sulfur in Petroleum Oils by Quartz Tube Combustion (D 1551 – 58 T)

This method is applicable to sulfur in concentrations ranging from 0.01 to 5.0 per cent, and particularly to materials that cannot be analyzed directly by ASTM Method D 1266, Test for Sulfur in Petroleum Products Including Liquefied Petroleum Gas by Lamp Combustion. These include materials such as lubricating oils, fuel oils, gas oils, asphalts, and substances whose sulfur contents are above 3 per cent. The method provides a correction for the presence of

chlorine which makes it useful for the analysis of lubricating oils that have been blended with organic additives containing chlorine. The method gives erroneous results when applied to materials containing phosphorus and many metallo-organic compounds.

Analysis of Graphites Used as Lubricants (D 1553 – 58 T)

These methods include procedures for determining the volatile matter (including moisture) and of incineration ash of natural or manufactured graphites used as lubricants. The graphite to be analyzed must not contain other solvents or liquids.

Sulfur in Petroleum Products by the Rapid, High-Temperature Combustion Method (D 1552 – 58 T)

This method describes two procedures for the determination of total sulfur in petroleum products, including lubricating oils containing additives, and additive concentrates. The method is applicable to samples boiling above 350 F and containing not less than 0.05 per cent sulfur. Chlorine in concentrations less than 1 per cent does not interfere. Nitrogen when present in excess of 0.1 per cent may interfere; the extent of such interference may be dependent on the type of nitrogen compound as well as the combustion conditions. The alkali and alkaline earth metals, as well as zinc, phosphorus, and lead, do not interfere.

Flash Point by Pensky-Martens Closed Tester (D 93 – 58 T)

This method is a revision of and replaces the former Standard Method D 93 – 52. It is applicable to determining the flash point of fuel oils as well as viscous materials and suspensions of solids. It is not applicable to the testing of drying oils, solvent-type liquid waxes or cutback asphalts. The apparatus used with this method is now covered by separate tentative Specifications E 134 – 58 T as listed below under Committee E-1.

ROAD AND PAVING MATERIALS (D-4)

Methods of Test for:

Resistance to Plastic Flow of Bituminous Mixtures by Means of the Marshall Apparatus (D 1559 – 58 T)

The Marshall apparatus was introduced and used by the Corps of Engineers, Department of the Army. The procedure is intended to measure the resistance to plastic flow or movement of bituminous mixtures. Cylindrical specimens 4 in. in diameter by 3 in. in height are compressed to a maximum load with the flow being measured by a flow meter.

Resistance to Deformation and Cohesion of Bituminous Mixtures by Means of Hveem Apparatus (D 1560 – 58 T)

Resistance to deformation is one of the primary properties of bituminous mixtures which influence the quality of a bituminous road surface. This procedure makes use of the Hveem apparatus which is based on a stabilometer which is a triaxial testing device consisting essentially of a rubber sleeve within a metal cylinder containing a liquid which registers the horizontal pressure developed by a compacted test specimen as a vertical load is applied. As part of this method of test an additional apparatus known as the Hveem cohesiometer is also used to determine the cohesion of compacted bituminous mixtures by measuring the force required to break or bend the sample as a cantilever beam.

Preparing Bituminous Mixtures by Means of California Kneading Compactor (D 1561 – 58 T)

The preparation of bituminous paving mixtures for testing purposes in the laboratory to simulate actual road compaction has always been a difficult problem. This method makes use of a kneading action to consolidate the test specimens which is comparable to the action in the road under field compaction methods. The California Kneading Compactor is the basic apparatus used; it creates a series of individual impressions made with a ram on the specimen material.

Density of Soil in Place by the Sand-Cone Method (D 1556 – 58 T)

There have been a number of methods and apparatus used to determine artificially the in-place density of soils. This method involves the use of a sand-cone apparatus consisting essentially of a 1-gal jar and a detachable appliance consisting of a cylindrical valve between a small funnel on top and a large funnel below. The apparatus is restricted to soils containing particles not larger than 2 in. in diameter.

Moisture-Density Relations of Soils Using a 10-lb Rammer and an 18-In. Drop (D 1557 – 58 T)

Moisture-density relationship is an important item in the use of soils for engineering purposes. This relationship can now be calculated after completion of test methods described which determine the optimum moisture content and the maximum density. The apparatus involves the use of a 10-lb rammer dropped from a height of 18 in. into a compacted sample in a cylindrical mold. Four alternate procedures are offered which differ in respect to the diameter of the mold and the top size of the soil material.

Moisture-Penetration Resistance Relations of Fine-Grained Soils (D 1558 – 58 T)

The moisture-penetration resistance relationship is also considered important in soils engineering. This method is intended to establish the moisture-penetration resistance relations of fine-grained soils as determined by the soil penetrometer. The relationship is established by plotting the penetration resistance determinations using the penetrometer which consists of a special spring dynamometer with pressure indicating scale and using a penetrometer needle consisting of several sizes. These determinations are plotted against corresponding moisture contents.

COAL AND COKE (D-5)

Method of Test for:

Cubic Foot Weight of Crushed Bituminous Coal (D 291 – 58 T)

A new revision of this method represents a complete departure from the 1929 method. The earlier edition utilized an ordinary scoop or shovel in which the coal was simply dropped into a box of 1 cu ft in volume. Over the years it has been increasingly evident that dropping the coal from a shovel cannot be accomplished in a standard manner and, as a result, a standard cone was developed. Considerable attention has been given to the cone procedure as well as a standard method of dropping the coal in order to obtain a figure for the compacted cu ft weight. These studies have resulted in the establishment of a reproducible method of determining this characteristic of coal.

WOOD (D-7)

Definitions of:

Terms Relating to Wood-Base Fiber and Particle Panel Materials (D 1554 – 58 T)

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The terms included in these definitions are intended to apply to a family of lignocellulosic panel materials specially manufactured for use industrially as components, which may be core, facing, or panels, of furniture, cabinets, and the like. This material is also used in building construction as siding, sheathing, partitions, door cores and paneling, acoustical treatments, and as structural components where the combination of thickness, panel size, and properties satisfy a particular need.

ELECTRICAL INSULATION MATERIALS (D-9)

Method of Test for:

Peroxide Number of Mineral Insulating Oils (D 1563 – 58 T)

This method provides a definite procedure, not heretofore available, for measurement of peroxides which are sometimes found in oxidized mineral oils.

RUBBER (D-11)

Specifications and Methods of Test for:

Flexible Foams Made from Polymers or Copolymers of Vinyl Chloride (D 1565 – 58 T)

These specifications and methods of test apply to cellular products containing interconnecting cells made of a base material known as poly(vinyl chloride) or copolymers thereof. They cover both cored and uncored vinyl foam products. Included in an appendix for information only are tolerances on dimensions of vinyl foam products for general applications, and for special applications such as automotive topper pads, spring coverings, etc. These specifications and methods were prepared jointly by the ASTM and the Society of the Plastics Industry.

Method of Test for:

Flexible Urethane Foam (D 1564 – 58 T)

These methods of test apply to flexible cellular foams known as urethane foam which is defined as an expanded cellular product produced by the interaction of polyhydroxy compounds, water, and isocyanates. Included in an appendix for information only are a general specification foremat and tolerances on dimensions of urethane foam products.

Definitions of

Terms Relating to Rubber and Rubber-Like Materials (D 1566 – 58 T)

The terms covered are: abrasion resistance index, hardness, international rubber hardness degree, mechanical stability of latices, swelling, tear strength, tensile strength, tensile stress, tensile stress at given elongation, and test specimen. These terms have been selected from the ASTM "Glossary of Terms on Rubber and Rubber-Like Materials," *ASTM Special Technical Publication No. 184* and from other sources.

SOAPS AND OTHER DETERGENTS (D-12)

Methods for Sampling and Chemical Analysis of:

Alkylbenzene Sulfonates (D 1568 – 58 T)

Fatty Alkyl Sulfates (D 1570 – 58 T)

These methods cover procedures for sampling and analysis of two important types of synthetic detergents.

Methods of Testing:

Detergent Alkylate (D 1569 – 58 T)

These methods actually consist of a listing of various existing methods of test, most of them under the jurisdiction of Committee D-2 on Petroleum Products and Committee D-16 on Industrial Aromatic Hydrocarbons, that may be used to evaluate the properties of detergent alkylates in order that these materials may be characterized as to their suitability for intended uses in detergent products.

Method of Testing:

Detergent Cleaners for Evaluation of Corrosive Effects on Certain Porcelain Enamels (D 1567 – 58 T)

This method covers a procedure for evaluation of the corrosive effects of detergent cleaners on certain types of porcelain enamels, particularly those used on working surfaces of clothes washing and dishwashing machines. The method is intended only for determining relative corrosion characteristics of cleaners. It is not intended as a measure of the life of the cleaner nor as a method for evaluation of relative resistance of various enamels to corrosive effects of detergents.

TEXTILES (D-13)

Specifications of Methods of Test for:

Industrial Asbestos Tapes (D 1572 – 58 T)

These specifications and methods apply to industrial asbestos tape $\frac{1}{32}$ inch in thickness and over, woven from plain asbestos yarn.

Woven Asbestos Cloth (D 1571 – 58 T)

Requirements are presented for 21 grades of woven asbestos cloth. These specifications, together with the new specifications for asbestos tape, are two important additions to the existing ASTM standards for asbestos textile products.

Methods of Test for:

Heat Aging of Asbestos Textiles (D 1573 – 58 T)

This method of test is intended for use in the evaluation of asbestos textiles with regard to (1) quality and (2) elevated temperature serviceability characteristics. Since asbestos textiles are usually composed of blends of asbestos with cotton, the latter being present in amounts up to 25 per cent, temperatures above 300 F will promote the degradation of the cotton content and will reduce the structural reinforcement derived therefrom.

Linear Density of Textile Fibers by the Vibroscope (D 1577 – 58 T)

The vibroscope method is based on the principle that the weight per unit length of a completely flexible string or fiber can be calculated directly, if the natural frequency of transverse vibration is determined when a measured length is held under a known tension. This method determines the weight per unit length (linear density) of fibers, where the difficulties attendant on direct weighing become increasingly formidable and time-consuming, as in the case of staple below about 1.0 tex. It may also provide advantages over microscopical measurement in certain cases, such as when the specimen is to be preserved intact for additional tests, or where calculation from dimensions obtained microscopically could introduce uncertainties, involved measurements, or inadequate precision.

Moisture in Wool by Oven Drying (D 1576 – 58 T)

This method of test applies to ordinary commercial and industrial testing of samples of wool in all forms, except wool in the grease. Formulas for calculating the moisture content (wet basis) and moisture regain (dry basis) are given.

Extractable Matter in Oven Dried Wool (D 1574 – 58 T)

This method of test determines the extractable matter in oven-dried samples of all forms of wool, except wool in the grease. The results of this test may be used together with the results of the test for loss on oven drying as determined by the Method of Test for Moisture in Wool by Oven Drying (D 1576 – 58 T) to provide the total extractable and oven volatile matter present in the original sample.

This method is intended to be general in nature and to allow determination of matter extractable by any given solvent chosen for convenience or special purpose as long as the particular solvent used is stated in reporting the test results. A combination of solvents used simultaneously or successively may also be used, with appropriate notation in reporting the results.

Fiber Length of Wool (D 1575 – 58 T)

This method determines the fiber length of wool in assemblies whose fibers have not been paralleled, such as scoured wool and card sliver. The fiber length of wool is expressed in terms of the arithmetic mean in inches and hundredths of an inch. The distribution of length is expressed by the standard deviation, or by a frequency or cumulative frequency curve.

Breaking Strength of Yarn by Skein Method (D 1578 – 58 T)

This method is applicable to all yarns, either singles or plied, composed of any fiber or blend of fibers. It is intended primarily for quality control and acceptance testing, for it provides a useful index which depends upon variability as well as single-strand strength. When used in combination with the method for yarn number it provides a useful means for comparing the breaking strength or tenacity of yarns differing in number.

ADHESIVES (D-14)

Methods of Test for:

Bonding Permanency of Water or Solvent Soluble Liquid Adhesives for Labeling Glass Bottles (D 1581 – 58 T)

Water Absorptiveness of Paper Labels (D 1584 – 58 T)

Specification for:

Adhesives for Automatic Machine Labeling of Glass Bottles (D 1580 – 58 T)

The properties of adhesives used for automatic machine labeling are of an entirely different order from those adhesives in which time is not a critical factor. A project initiated in Committee D-14 two years ago to cover this field has resulted in these three standards.

Methods of Test for:

Nonvolatile Content of Phenol, Resorcinol, and Melamine Adhesives (D 1582 – 58 T)

Measuring the Hydrogen Ion Concentration of Dry Adhesive Films (D 1583 – 58 T)

Filler Content of Phenol, Resorcinol, and Melamine Adhesives (D 1579 – 58 T)

Continuing its program of developing methods which will further characterize the physical and chemical properties of adhesives, the committee is presenting these three methods.

ENGINE ANTIFREEZES (D-15)

Specifications for:

Hydrometer-Thermometer Field Tester for Engine Antifreezes (D 1124 – 58 T)

These specifications have been revised to provide the hydrometer manufacturers with a uniform method of calibrating antifreeze hydrometers up to and including a higher liquid density range than defined in the previous edition. The earlier edition permitted high-density liquids to be measured with a pycnometer and, since values obtained with this instrument were often quite different from those obtained with a calibrated hydrometer, a revision of this method was necessary.

AROMATIC HYDROCARBONS AND RELATED MATERIALS (D-16)

Method for:

Calculation of Volume and Weight of Benzene, Toluene, and Paraxylene (D 1555 – 58 T)

The calculating tables presented by Committees D-2 and D-16 provide a method of making the volume-weight conversion of benzene, toluene, and paraxylene. This method fills the need for a standard set of tables which can be used by all shippers and which will eliminate the slightly differing figures which have often posed difficulties in the past.

NAVAL STORES (D-17)

Methods of Test for:

Fatty Acids Content of Tall Oil Rosin (D 1585 – 58 T)

This is an improved method for determining the fatty acids content of tall oil rosin. This test is important in that Federal Standards and Trade Specifications call for tall oil rosin containing not more than 5 per cent residual fatty acids. The method includes two procedures for determining the fatty acids both of which have given good agreement during the interlaboratory collaborative test programs.

SOILS (D-18)

Methods for:

Thin-Walled Tube Sampling of Soils (D 1587 – 58 T)

The problem of securing relatively undisturbed samples of foundation soils for laboratory tests is greatly assisted by the use of this method. There are, in general, two types of samplers that use thin-walled tubes for sampling, namely, open-tube samplers and piston-type samplers. This method applies to both types of apparatus. There are limits described as to the use of this method and caution is noted that the samples are not necessarily sufficiently undisturbed to be suitable for all types of laboratory tests and for all field conditions.

Penetration Test and Split-Barrel Sampling of Soils (D 1586 – 58 T)

This method combines a means of obtaining representative samples of soils for identification purposes and other laboratory tests, as well as obtaining a record of the resistance of the soil to penetration of the sampler.

INDUSTRIAL WATER (D-19)

Methods of Test for:

Dissolved and Gaseous Hydrogen in Industrial Water (D 1588 – 58 T)

These methods cover a procedure for continuous, automatic recording of the concentration of dissolved and gaseous hydrogen in industrial water as determined from variations in thermal conductivity of a flowing sample, and also a non-referee procedure for volumetric determination of hydrogen in collected samples of water.

Dissolved Oxygen in Industrial Waste Water (D 1529 – 58 T)

These methods are designed for the determination of dissolved oxygen in the presence of the substances commonly found in industrial waste water that would interfere in the Method of Test for Oxygen in Industrial Water (D 888 – 49 T). Four different methods are covered.

Effect of Water in Tubular Heat Exchangers (D 1591 – 58 T)

This method is, in effect, a simulated service test for evaluating the tendency of an industrial water to produce corrosion or deposits in metallic tubes in a heat exchanger.

Surface Tension of Industrial Water and Industrial Waste Water (D 1590 – 58 T)

This method covers a procedure for quantitative measurement of surface tension of industrial water and industrial waste water. It is not intended to show any direct relationship with concentration of surface-active agents.

PLASTICS (D-20)

Abbreviations of:

Terms Relating to Plastics (D 1600 – 58 T)

The designation of plastics and raw materials used in plastics by abbreviations has become common practice and there is a need for standardization.

Specifications for:

Glass Fabric Reinforced Epoxy Resin Laminates (D 1592 – 58 T)

This specification, developed jointly with Committee D-9, establishes sheet dimensions and properties for applications requiring a combination of good mechanical and electrical properties.

Method of Test for:

Determination of Dilute Solution Viscosity of Ethylene Polymers (D 1601 – 58 T)

Solution viscosity is recognized as an important research and development tool for ethylene polymers. It can furnish useful information on a series of homologous polymers.

Bearing Load of Corrugated Reinforced Plastics Panels (D 1602 – 58 T)

This specification is the outgrowth of work started by the Society of the Plastics Industry. The objective has been to afford information concerning panels when fasteners are used in installation.

Determining Carbon Black in Ethylene Plastics (D 1603 – 58 T)

This method is needed for establishing specification requirements on weather-resistant grades of black polyethylene.

Flatness of Plastics Sheet or Tubing (D 1604 – 58 T)

This method provides a convenient procedure for determining flatness, the lack of which is characterized by fullness of the sheet and causes wrinkling.

Time-to-Failure of Plastic Pipe Under Long-Term Hydrostatic Pressure (D 1598 – 58 T)

This method is needed for establishing specification requirements on plastic pipe.

Short-Time Rupture Strength of Thermoplastic Pipe, Tubing, and Fittings (D 1599 – 58 T)

This test is suited for establishing laboratory testing requirements for procurement specifications. In no way do the results of this test indicate the long-term strength of plastic pipe.

Specifications for:

Non-Rigid Vinyl Chloride Plastic Sheeting (D 1593 – 58 T)

This specification designates three general purpose types of vinyl chloride plastic sheeting. Several tests are included, the results of which are useful for inspection and quality control.

Methylstyrene-Acrylonitrile Copolymer Molding and Extrusion Material (D 1594 – 58 T)

Covers property requirements for injection molding and extrusion applications.

Polymethylstyrene Molding and Extrusion Material (D 1595 – 58 T)

Outlines properties and test methods for characterizing this material.

Polyethylene Molding and Extrusion Materials (D 1248 – 58 T)

This is a major revision of the specification for polyethylene. It establishes three types based on density ranges with several classes for each type. It is expected that the specification will help greatly to alleviate the confusion that has been evident concerning the many varieties of polyethylene available commercially.

ATMOSPHERIC SAMPLING AND ANALYSIS (D-22)

Methods of Test for:

Nitrogen Dioxide and Nitric Oxide Content of the Atmosphere (Modified Griess-Ilsovay Reaction) (D 1607 – 58 T)

Oxides of Nitrogen in Gaseous Combustion Products (Phenol-Disulfonic Acid Procedure) (D 1608 – 58 T)

These new tentative methods provide standardized procedures for determining oxides of nitrogen which occur in the atmosphere and in combustion processes under a variety of conditions. Nitrogen oxides are often considered undesirable constituents and accurate methods for determining the amounts present are useful in controlling the levels.

Recommended Practices for:

Sampling Atmospheres for Analysis of Gases and Vapors (D 1605 – 58 T)

This new tentative provides recommendations for sampling atmospheres either with or without concentration of the gases and vapors during the sampling procedure. Typical gases and vapors which the recommended practice covers are hydrogen sulfide, sulfur dioxide, acetylene, and oxides of nitrogen.

Methods of Test for:

Oxidant Content of the Atmosphere (D 1609 – 58 T)

This method is intended for the determination of low concentrations of oxidant which may, or may not be, all, or part, ozone. The method detects oxidant expressed as ozone within the range of 1 to 16 μg.

Inorganic Fluoride in the Atmosphere (D 1606 – 58 T)

The method covers sample collection, preparation, distillation, and titration procedures. It is not applicable to determination of certain organic fluoride compounds which require more drastic treatment.

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CELLULOSE AND CELLULOSE DERIVATIVES (D-23)

Method of Test for:

Moisture in Cellulose (D 1348 – 58 T)

This method is being enlarged to include a method for chemically determining the water content of cellulose. The former method contained only physical methods for moisture determination.

LEATHER (Joint ALCA-ASTM)

Method of:

Conditioning Leather and Leather Products for Testing (D 1610 – 58 T)

The moisture content and physical condition of leather generally vary with the conditions of the atmosphere to which the leather is exposed in such a way as to affect test results. Therefore, in order to obtain reproducible and reliable test results in different laboratories or within a laboratory on different days, it is necessary to standardize the temperature and the humidity conditions to which leather is exposed prior to and during testing.

Method of Test for:

Corrosion Produced by Leather in Contact with Metal (D 1611 – 58 T)

The procedure is primarily intended to evaluate chrome leather intended for use in hydraulic systems under circumstances where metal corrosion is a serious factor. A high relative humidity is used to accelerate the test.

METHODS OF TESTING (E-1)

Specifications for:

Distillation Equipment (E 133 – 58)

These specifications cover distillation equipment used in the following ASTM methods: Distillation of Petroleum Products (D 86); Distillation of Gas Oil and Similar Distillate Fuel Oils (D 158); Distillation of Natural Gasoline (D 126); Distillation of Plant Spray Oils (D 447); Distillation of Industrial Aromatic Hydrocarbons (For approved alternate requirements only) (D 850) and Distillation Range of Lacquer Solvents and Diluents (D 1078).

Pensky-Martens Closed Flash Tester (E 134 – 58 T)

This is the first specification prepared by Subcommittee 21 on Metalware Laboratory Apparatus covering a particular type of test instrument. Detailed requirements are presented for the flash tester including the test cup, the test cup and lid assembly, and the cover. References to these specifications will be made in various ASTM methods which use the Pensky-Martens Flash Tester.

Method of Test for:

Determination of Poisson's Ratio at Room Temperature (E 132 – 58 T)

This method covers apparatus, specimens, and procedures for the determination of Poisson's ratio from tension tests of structural materials at room temperature. The method is limited to specimens of rectangular section and to materials in which creep is negligible compared to the strain produced immediately upon loading. Poisson's Ratio is defined as the absolute value of the ratio of transverse strain to the corresponding axial strain for uniformly distributed axial stresses below the proportional limit of the material.

(*Continued on page 51*)

Standards, Key to Progress and Profits

THE proceedings of the 8th National Conference on Standards sponsored by the American Standards Assn. in San Francisco, November, 1957, have recently been published. The book contains the addresses and remarks of 47 leading standards men based on the theme of the meeting—Standards, Key to Progress and Profits. The conference, composed of 11 sessions, covered such topics as cost improvement, industrial standardization for defense, and standardization for technical communication.

Archibald T. McPherson, associate director of the National Bureau of Standards speaking on Government and Industry's Use of Common Standards stated:

> In embarking on a program for the maximum use of industry standards, the Government should not give up responsibility for its own standards. Differences in purpose may make many excellent industry standards less than suitable for Government use. Instead, the Government should maintain competence in the technology of the products with which it has large concern so that it can determine which industry standards it can use in their entirety and which can be used with the minimum modification and adaptation. For purposes of clarity and to prevent misunderstanding in purchasing operations, it is important for the Government to issue its own standards documents, even though this may mean the extensive inclusion of standards from other sources.

Outlining purchasing's contributions to cost reduction through standards H. W. Christensen of Columbia-Geneva Steel Division, United States Steel Corp., stated in part:

> . . .Purchasing cannot help being receptive to standards that result in such benefits as the following: (1) Opens up multiple sources of supply where only one existed before. (2) Provides a clear and equitable basis for competitive bidding—thus broadens competition and promotes fairness because comparisons can be easily made. . . .

S. H. Watson, Radio Corporation of America, in a paper presented at the session on Standardization in the Electronics Industry said:

> There is no such thing as fixation as a result of standardization. On the contrary, standards and standardization secure and consolidate conquered areas and enable the scientists and engineers of the electronics industry to forge ahead.

Mervyn C. Nystrom of the Southern Pacific Co., speaking before the Profits by Standards group in the Railroad Industry session said, ". . .there is money to be made and saved by an aggressive and enlightened standardization campaign. This is a fact, not a theory. The conclusion in our case is based on experience."

Rolf T. Retz of the California State Department of Public Works, stated that the greatest value for a public agency is the fact that standards permit "open" specifications. "This means that. . .standards insure competition. The architect must try to get quality at the lowest possible cost, whether public or private construction is involved. Competition is a must, with at least two, and preferably more, competitors bidding on an item. Standards permit exactly that."

ASTM, through its Northern California District participated in the conference by sponsoring the session on Cost Improvement Through Standardization. G. J. Grieve, Pacific Paint and Varnish Co., presided.

Overseas Group Formed for Construction Workers

A new membership organization known as "Overseas Americans," has recently been formed to include as members construction and engineering workers who are interested in overseas projects. It will act as a clearing house for collecting, analyzing, and exchanging information pertaining to foreign construction and engineering projects now being built or proposed.

Monthly bulletins will be issued containing latest information on foreign construction projects that may be of interest to their members. In addition, 175 firms now doing overseas construction and engineering work will be invited to use the membership files to recruit qualified workers.

Headquarters are at 7 West 44th St., New York 36, N. Y.

Challenges in Materials Research

Drying of Plaster Prior to Painting

Contributed by Committee C-11 on Gypsum

The Administrative Committee on Research sponsors the publication from time to time in the BULLETIN of statements of problems in the materials fields representing challenges in materials research. It is hoped that by disseminating such information on materials research problems, contributions toward their solution might be forthcoming from sources outside the membership of the committee originating the problem. Comments and suggestions are welcome and will be forwarded to the originating committee.

Problem

Practically all painting specifications require that new plaster surfaces be painted "only when dry." Since the term "dry" is not specifically defined, and since field methods for measurement of the moisture content of the plaster do not appear to be readily available, interpretation is a matter of individual judgment. A conservative judgment of what is meant by "dry" may delay painting for several months. A non-conservative or wishful interpretation, on the other hand, may result in premature application of paint, with consequent failure of the decoration through:

1. Deterioration and discoloration of the paint film through alkali attack ("saponification") on the binder,
2. Color changes through alkali attack on the pigments, and
3. Failure of adhesion.

Difficulties of this kind arise chiefly in connection with solvent-type paints applied over finish coats containing lime. They do not occur when the plaster has ample opportunity for drying, regardless of how rapidly the drying may have taken place.

Present State of Knowledge

Limited data indicate that new plaster can be safely painted when the total moisture content of the slab has decreased to not more than about 2 per cent by weight. Measurement of moisture content by a test of the plaster surface is generally not reliable, since the interior of the plaster slab may contain seriously excessive amounts of moisture even when the surface appears to be dry.

Questions to Be Answered

1. What is the permissible maximum total moisture content of the plaster slab to insure successful painting?
2. With respect to 1, how can attainment of this condition be determined in the field?

Reference

Painting Plaster, by H. M. Llewellyn, Journal of the Royal Institute of British Architects, March, 1946, pp. 167–174.

Actions on Standards

The Administrative Committee on Standards is empowered to pass on proposed new tentatives and revisions of existing tentatives, and tentative revisions of standards offered between Annual Meetings of the Society. On June 18, 1958, the Standards Committee took these actions:

PAINT, VARNISH, AND LACQUER

Tentative Method of Specifying Color by the Munsell System (D 1535 – 58 T)

New Tentative.—This method provides means for specifying the colors of opaque objects in terms of the Munsell color system. It provides a simple and useful atlernative to the more precise but more complex Method of Test for Spectral Characteristics and Color of Objects and Materials (D 307-44) which is based on spectrophotometry and the CIE system.

Tentative Method of Test for Color Difference Using the Colormaster Differential Colorimeter (D 1536 – 58 T)

New Tentative.—This method covers the measurement of small color differences, observable in daylight illumination, between opaque nonfluorescent surfaces, such as paint specimens, by means of a commercially available instrument, the Colormaster differential colorimeter. The method will be a companion to the present four tentative color difference methods, D 1260 – 55 T, D 1365 – 55 T, D 1482 – 57 T, and D 1495 – 57 T.

ELECTRICAL INSULATING MATERIALS

Tentative Method of Test for Dielectric Constant and Dissipation Factor of Polyethylene Under Liquid Displacement (D 1531 – 58 T)

New Tentative.—This method provides procedures that are particularly suited to the precise determination of the dielectric constant of polyethylene compounds, in the vicinity of 2.28, at frequencies from 1000 cycles to 1 Mc and at a temperature of 23 C (73.4 F). It may be extended to cover a dielectric constant range from 2.00 to 3.00. It covers a dissipation factor range from 0.0001 to 0.1. The new principle of measurement which the method employs is an improvement over the direct electrode method of ASTM Methods of Test for A-C Capacitance, Dielectric Constant, and Loss-Characteristics of Electrical Insulating Materials (D 150).

Tentative Specifications for General Purpose Grade GPO-1 Polyester Glass-Mat Sheet Laminate (D 1532 –58 T)

New Tentative.—These specifications cover a general purpose grade of polyester glass-mat sheet laminate to be used for both mechanical and electrical applications. This grade is made from a mat of random-laid glass fibers, saturated with polyester resin combined with suitable fillers, curved by applying heat and pressure.

Tentative Method of Test for Determination of Water in Insulating Liquids (Karl Fischer Method) (D 1533 – 58 T)

New Tentative.—This method fills an industrial need for an improved method for determination of water, an objectionable impurity in insulating liquids. This method is based essentially upon the reduction of iodine by sulfur dioxide in the presence of water.

Tentative Method of Test for Approximate Acidity of Used Electrical Insulating Oil of Petroleum Origin (D 1534 – 58 T)

New Tentative.—This test provides a uniform procedure for making quick filed tests of the condition of oil in transformers and other electrical equipment.

Tentative Method of Test for High-Voltage, Low-Current Arc Resistance of Solid Electrical Insulating Materials (D 495 – 56 T)

Revision.—The Stainless steel electrodes have been added to those already specified.

Tentative Recommended Practice for Purchase of Uninhibited Mineral Oil Used in Transformers and Circuit Breaker (D 1040 – 54 T)

Revision.—The addition of a requirement for control of power factor is a further safe-guard against purchase of uninhibited oils that may be contaminated, or otherwise defective, and not revealed by other tests.

Tentative Specifications for Absorbent Laminating Paper for Electrical Insulation (D 1080 – 54 T)

Revision.—The "basis weight" requirements for absorbent laminating paper have been clarified.

Tentative Methods of Testing Hydrocarbon Waxes Used for Electrical Insulation (D 1168 – 54 T)

Revision.—Method of Test for Penetration of Bituminous Materials (D 5 – 52) has been found unsuitable for measuring penetration of wax, and reference to this method has been replaced by reference to the Method of Test for Needle Penetration of Petroleum Waxes (D 1321 – 57 T). Additions are also made to the scope statement.

Tentative Method of Test for Corrosive Sulfur in Electrical Insulating Oils (D 1275 – 53 T)

Revision.—The visual scale of ASTM Copper Corrosion Standards has replaced the descriptive scale in Table I.

Tentative Methods of Test for 2,6-Ditertiary-Butyl Para-Cresol in New Electrical Insulating Oils (D 1473 – 57 T)

Revision.—Significance statements have been added to the methods.

PLASTICS

Tentative Method of Test for Vicat Softening Point of Plastics (D 1525–58 T)

New Tentative.—This method of test covers a procedure for determining the temperature at which a specified needle penetration occurs when specimens are subjected to specified test conditions. The method is particularly suited to polyethylenes but may be used for other materials.

Tentative Method of Test for Determination of Bierbaum Scratch Hardness of Plastic Materials (D 1526 – 58 T)

New Tentative.—This method fills a need for a test to determine the relative resistance of a plastic surface to defacement by sharp abrasive particles as occurs in tableware, optical elements, and similar applications.

Continued on page 52)

ASTM Bulletin

JULY 1958

NO. 231

NINETEEN-SIXTEEN
RACE STREET
PHILADELPHIA 3, PENNA.

Materials Engineer:

Creator or Empiricist?

Engineers need materials to translate their ideas into reality, and they need control over phenomena to produce devices. If the properties of materials can be designed and the phenomena steered judiciously by an understanding of the underlying molecular causes, engineers become creators where at present they are empiricists. This mode of thinking about engineering problems "from the inside," by discerning the elementary particles and their interplay in gases, liquids, and solids, we call MOLECULAR ENGINEERING.

THE ABOVE is quoted from a brochure describing a 1956 summer program in Molecular Engineering at the Massachusetts Institute of Technology. MIT's Professor von Hippel who directed this program and who spoke on "Molecular Engineering" at the Annual Meeting (see page 14) has for several years been urging a closer cooperation among engineers and scientists in promoting materials knowledge. He has been joined by a number of others—by C. A. Hochwalt, Monsanto vice-president, speaking at an ASTM meeting in February and later reported in the May BULLETIN, by A. V. Astin of the National Bureau of Standards, speaking before the Washington (D. C.) Rubber Group in February and by other speakers in the Materials Research Frontiers Symposium at the Annual Meeting. All urge a more fundamental approach to materials science and engineering.

What does all this mean? Is this a sputnik inspired bandwagon? Is it a temporary fad? Or is it both a warning and a prediction of the future course of developments in the materials field. We are inclined to believe it is the latter. Indeed the seeds for it were laid a decade or more ago with new discoveries in solid state science and in increasing knowledge of the microstructure of materials.

ASTM is dedicated to promotion of knowledge of materials and the Society's publications over many years have included papers on the fundamental aspects of materials science. The 1929 Marburg Lecture by Saul Dushman (Cohesion and Atomic Structure) is a good example. So "Molecular Engineering" is not a new concept in ASTM.

But let us be realistic—in dealing with engineering materials as they are likely to be for some time still, empirical tests that offer reproducible results will continue to be essential. No doubt a certain amount of empiricism will always be with us.

In ASTM, we will continue to advance materials knowledge by whatever means including both "Molecular Engineering" and empirical tests.

—F. Y. S.

Engineers Told to Use Professional Writing Methods

Scientists, engineers, and other technically trained persons can write better and with less effort if they adopt the techniques of the professional writer. This was the theme of a talk by John L. Kent before a class of engineers at the Western Technical Writing Inst. in San Marino, Calif.

"These methods can be used easily in engineering reports, scientific articles, and other technical writing," Mr. Kent said. He asserted that with detailed planning, the scientist and engineer can produce more concise, yet complete reports.

"The professional writer plans his writing, considers his reader, and uses practical psychology to produce high-quality, readable writing in quantity, even when neither flesh nor spirit is willing." The engineer should do the same.

Schedule of ASTM Meetings

This gives the latest information available at ASTM Headquarters. Direct mail notices of all district and committee meetings customarily distributed by the officers of the respective groups should be the final source of information on dates and location of meetings. This schedule does not attempt to list all meetings of smaller sections and subgroups.

Date	Group	Place
Sept. 10	Joint SAE-ASTM Committee on Automotive Rubber	Detroit, Mich. (Rackham Memorial Bldg.)
Sept. 11-12	Committee C-3 on Chemical Resistant Mortars	Watertown, N. Y.
Sept. 15-17	Committee B-5 on Copper and Copper Alloys	Whiteface, N. Y. (Whiteface Inn)
Sept. 24-26	Committee E-14 on Mass Spectrometry, and Mass Spectrometry Panel of British Institute of Petroleum	London, England (Univ. of London)
Oct. 1-2	Committee C-8 on Refractories	Bedford, Pa. (Bedford Springs Hotel)
Oct. 5-9	Committee D-2 on Petroleum Products and Lubricants	Washington, D. C. (Sheraton Park Hotel)
Oct. 13-15	Committee C-16 on Thermal Insulating Materials	Madison, Wis. (Ivy Inn.)
Oct. 23	Committee D-15 on Engine Antifreezes	Philadelphia, Pa. (Sheraton Hotel)
Oct. 23-24	Committee B-1 on Wires for Electrical Conductors	Washington, D. C. (Sheraton Park Hotel)
Oct. 23-24	Committee B-4 on Metallic Materials for Electrical Heating, Electrical Resistance, and Electrical Contacts	Chicago, Ill. (Morrison Hotel)
Oct. 27-29	Committee D-20 on Plastics	Philadelphia, Pa. (Benj. Franklin Hotel)
Oct. 28-29	Committee B-9 on Metal Powders and Metal Powder Particles	Cleveland, Ohio (Manger Hotel)
Oct. 29-31	Committee D-9 on Electrical Insulating Materials	Philadelphia, Pa. (Benj. Franklin Hotel)
Oct. 30-31	International Symposium on Plastics	Philadelphia, Pa. (Benj. Franklin Hotel)
Oct. 13-14	Symposium on Cleaning Electronic Parts	Philadelphia, Pa. (Franklin Institute)
Nov. 20	Philadelphia District	Villanova, Pa.

NEW ASTM PUBLICATIONS

Symposium on Composition of Petroleum Oils

IN RECENT YEARS there have been spectacular developments in both procedures and instruments for chemical analysis. These new procedures and instruments have been applied extensively in the determination and evaluation of the various constituents of petroleum oils. In order to document these advances in a form readily usable by the petroleum chemist, Committee D-2 on Petroleum Products and Lubricants has sponsored the publication of the extensive Symposium on Composition of Petroleum Oils held in connection with a meeting of the committee in 1957. The preface to this symposium is reprinted on page 55.

CONTENTS

Separation—Session I

Volatility and Adsorption

Summary of Work of the API Project 6 on the Hydrocarbons in the C_{12} to C_{28} Fraction of Petroleum—Beveridge J. Mair and Frederick D. Rossini

Determination of the Paraffin, Monocyclic and Dicyclic Naphthene Contents of a Middle East Gas Oil by Selective Adsorption—H. C. Rampton

Composition of an East Texas Lube Oil Distillate—B. A. Orkin, J. G. Bendoraitis, B. Brown, and R. H. Williams

Thermal Diffusion

New Thermal Diffusion Techniques Applicable to High-Boiling Petroleum Fractions—A. L. Jones

The Separation of High-Boiling Petroleum Oils by Thermal Diffusion—F. W. Melpolder, R. W. Sauer, and T. A. Washall

Solvent Extraction

Solution Behavior Patterns as Supplement in Analysis of Oil Fractions—E. L. Derr, C. H. Deal, and G. J. Pierotti

Spectroscopic Methods—Session II

Infrared

Determination of Methyl, Methylene, and Alkyl Benzene Group Types by Infrared Absorption—R. H. Hughes and R. J. Martin

Mass Spectrometry

Analysis of Petroleum Oils by Mass Spectrometry—E. G. Carlson and M. J. O'Neal

Nuclear Magnetic Resonance

Characterization of Hydrocarbons in Petroleum by Nuclear Magnetic Resonance Spectrometry—R. B. Williams

The Influence of Intermolecular Interactions on Nuclear Magnetic Resonance Chemical Shift Measurements as Related to Certain High Molecular Weight Hydrocarbon Systems—J. R. Zimmerman and J. A. Lasater

General Methods and Correlations—Session III

The Composition of Petroleum Distillates as Revealed by Their Sulfonates—A. B. Brown and J. O. Knobloch

Comparison of Methods for Obtaining Carbon-Type Analyses of Viscous Oils—W. J. Stout, R. W. King, M. E. Peterkin, and S. S. Kurtz, Jr.

Comparison of Structural Group Analyses by Spectrometric and Physical Property Methods—S. H. Hastings, B. H. Johnson, H. E. Lumpkin, and R. B. Williams

Molecular Weight Determination

Molecular Weight Determination—F. H. Stross

A Correlative Method for Structure of Solid Saturated Hydrocarbons— G. G. Rumberger and R. W. Dannenbrink

General Discussion

STP 224; 294 pages; cloth cover; price $5.50; to members, $4.40.

Brittle Fracture of Rotor Forgings

Many forgings are of such nature that destructive methods of test are not economically feasible. Size and geometric configurations present special problems when nondestructive procedures are used. Modern rotors of large size used at high speeds demand exacting test and inspection techniques.

This symposium treats some of the requirements for rotor forgings as well as problems of test and inspection. It had the participation of a number of engineers and was held as a special meeting convenient for those who were delegates to the World Metals Congress in November 1957.

CONTENTS

Introduction—N. L. Mochel

Inspection of Large Rotor Forgings—George E. Danner

Rotor Forgings for Power Equipment Manufacturers—T. G. Foulkes

The Work of the Task Group on Brittle Failure with Respect to Research—A. O. Schaefer

Requirements for Turbine and Generator Rotor Forgings—A. W. Rankin

Influence of Geometric Factors on Results of Ultrasonic Testing of Heavy Forgings—Helmut Krainer and Ekkehardt Krainer

Thoughts on the Question of Axial Test Boring in Rotor Bodies—K. von Kreitz

STP 231; 48 pages; hard cover; price $2.00; to members, $1.60.

Elevated Temperature Properties of Chromium Steels

12–27 per cent

THIS is one of a series of reports on the elevated temperature properties of various metallic materials prepared under the auspices of the Data and Publications Panel of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals. It includes data for tensile and yield strength, elongation, reduction of area, creep and rupture properties. Twenty-three alloys are covered ranging from 12 to 27 per cent chromium.

Data contained in this report are arranged in the form of graphs and data sheets. Most of the information came principally from data sheets supplied by the cooperating laboratories, and some data have been from trade bulletins and the published technical literature. Certain data sheets include rupture strength data that have been extrapolated by the Larson-Miller parameter method as well as by the usual log-log curves. When available, both values were indicated.

The information in the publication is so organized that the graphs are neatly tied in with the data sheets. For example, for any data point on the graph, it is possible to refer to the proper data sheet to check chemical composition, heat treatment, processing, etc.

Other reports in this series have covered the high-temperature properties of austenitic stainless steels, the chromium-molybdenum steels, superstrength alloys, carbon steels, copper-base alloys, wrought medium-carbon alloy steels and the strength of weldments. The engineering data presented in this series of publications should be of particular use to engineers and designers.

STP 228; 124 pages; paper cover; price $4.25; to members, $3.40.

Tentative Guide for
Fatigue Testing and The Statistical Analysis of Fatigue Data

THIS GUIDE covers principal procedures and techniques for analyzing fatigue data. It includes definitions of certain statistical terms and only enough of the basic concepts of statistics to make the methods understandable. Theory is left to the references which are more than adequate.

The purposes of fatigue testing among others, are to estimate the relationship between stress and the number of cycles-to-failure for a given material or component and, secondly, to compare the fatigue properties of two or more materials or components. It is essential that these estimates be based on the results of testing—using acceptable testing procedures—the samples of fatigue specimens drawn at random from a population of possible fatigue specimens. This guide provides information of the most efficient use of a limited number of test specimens and on the number of test specimens required to give a specified degree of confidence in the test results.

One of the difficulties in analyzing fatigue data is the interpretation of scatter. A "mean curve" drawn through the data may not provide enough information. For example, material which has a higher mean fatigue strength, but a considerable amount of scatter, may be less suitable than a material which has a lower fatigue strength, but which has a small amount of scatter. This statistical treatment presented in this guide will assist the test engineer in his analysis of such data.

While the guide is essentially for workers in the field of fatigue, the concepts are of basic importance to designers and engineers. Some of the material should be included in engineering courses at universities.

This guide, sponsored by ASTM Committee E-9 on Fatigue, is the composite work of many people who have contributed a great deal of time to the discussion and writing of the text. Its development has covered a period of about six years, and its publication marks a milestone in the use of statistical analysis of fatigue data.

STP 91-A, 90 pages; paper cover, price $3.75; to members, $3.

Elevated Temperature Strain Gages

IN RECENT years the increasingly higher temperature to which airframes are subjected has necessitated a more detailed evaluation of the strain gage. In addition, the design of nuclear reactor structures and other new industrial and military projects have resulted in an increasing need for strain gages capable of measuring static strains at temperatures above 600 F.

The Symposium was held at the Naval Air Material Center, Philadephia, on December 4 and 5, 1957. Cdr. H. J. Huester, Assistant Director of the Aeronautical Structures Laboratory, was general chairman.

Subjects covered include calibration techniques and instruments, gage alloys, foil gages, weldable gages, bonding agents, and temperature compensation. It is to be noted that no investigator has reported upon a device to replace the resistance gage, although the shortcomings of the latter at elevated temperatures are well documented in this book.

CONTENTS

Introduction—D. E. Weiss
Development and Application of High-Temperature Strain Gages for Stress Measurements in Jet Engines—B. R. Anderson
Progress on Metalfilm Strain Gages—W. T. Bean, Jr.
A Facility for the Evaluation of Resistant Strain Gages at Elevated Temperatures—R. L. Bloss
Synthetic Mica Gage—G. A. Brewer
Recent Laboratory Evaluation of High Temperature Strain Gages at 900 F—E. E. Day
High Temperature Strain Gage Testing at Rolls Royce—D. A. Drew
Laboratory Evaluation of Nichrome Foil Strain Gage Insulations Up to 1200 F—W. R. Forlifer
Temperature Compensation Techniques—R. Friedman
Development of High Temperature Strain Gage Wire—W. H. Graft
Temperature Compensation of High-Temperature Strain Gages—E. I. Gray, A. Grossman, and M. R. Rubin
Installation of Foil Gages for High-Temperature Applications—F. F. Hines
Optical Strain Gages for Use at Elevated Temperature—H. K. Howerton
Advances in Static and Dynamic High Temperature Strain Gage Research—R. H. Kemp
Bakelite Strain Gages for Temperatures Between −320 and 450 F—D. J. Madsen
High Temperature Strain Gage Evaluator—C. K. Martina
Stability of Strain Gage Alloy Wires—A. G. Metcalfe
Bonding Agents for High-Temperature Strain Gages—D. G. Moore
Resistance Measurements of Ceramic Type Strain Gage Cements—J. W. Pitts, E. Buzzard, and D. G. Moore
Evaluation of Several Gage Configurations Fabricated with Armour Alloy "D"—J. J. Shrager
Ceramic Coatings for Experimental Stress Analysis—F. B. Stern, Jr.
Elevated Temperature Strain Gage Investigator at Grumman Aircraft Engineering Corporation—R. J. Stewart
Investigation of Strain Gages for Long Term Static Testing to 650 F—H. Yanowitz, I. Berman, and A. Bleiweis
Problems of Thermal Stress Measurements—D. J. Demichele

STP 230; 168 pages; hard cover; price $4.50; to members, $3.60.

Procedures for Testing Soils

This publication contains 112 methods for testing soils. Of these, 39 are new and 12 are revised since the last edition of this publication in 1950.

The science of soil mechanics is a complex one, due to the very nature of the materials involved which vary, not only geographically, but locally as well. This variability of soils makes it especially difficult to develop standard methods of test that can be universally used for evaluating the engineering properties of soils.

ASTM Committee D-18 on Soils for Engineering Purposes has sponsored this publication. The ASTM standards on testing soil, which are included, are the result of general agreement and acceptance. Together with these standards are included proposed and suggested methods of test that have, in general, received wide recognition in the United States. A good many of these latter methods may ultimately become ASTM Standards.

This publication is the only one that brings together in convenient form all of these various methods now in current use.

The soil test procedures are grouped into five categories, each pertaining to related phases of soil testing, as follows:

Part I. Soil Explorations and Sampling of Soils.

Part II. Physical Characteristics, Physio-Chemical Properties, and Identification of Soils.

Part III. Physical and Structural Properties of Soils.

Part IV. Special and Construction Control Tests.

Part V. Soil Bearing Tests, Dynamic Properties of Soils, and Load Tests on Piles.

Procedures for Testing Soils; 552 pages; paper cover; price $6.75; to members, $5.40.

Manual for Rating Aviation Fuels by Supercharge and Aviation Methods

THIS VOLUME contains the methods for testing the knock characteristics of aviation fuels by the supercharge and aviation methods. It supersedes these sections previously covered in the 1952 ASTM Manual of Engine Test Methods for Rating Fuels bringing the information up to date at the same time.

This book contains two methods: Supercharge Method D 909 and Aviation Method D 614. Each method is amplified by six extensive appendices. The first appendix relates to apparatus, the second to reference materials and blending accessories, the third is on operation, the fourth on maintenance, the fifth on installation and assembly, and the sixth on building and utility requirements.

Manual for Rating Aviation Fuels by Supercharge and Aviation Methods; 332 pages; cloth cover; price $16.00; to members, $13.50.

Rubber and Rubber-Like Materials

Compilation of Standards, D-11

THE RANGE of methods of test and specifications contained in this volume makes it of considerable interest not only to the rubber chemist, design engineer, and rubber manufacturer, but also to the electrical engineer, purchasing agent, and quality control engineer.

There are 145 standards, of which 61 are new, revised, or have had their status recently changed. Sixteen standards not included in the previous edition have been added. Many of these pertain to carbon black and synthetic rubbers and elastomers.

Among the general subjects covered are: processibility tests, interlaboratory tests, chemical and physical tests of vulcanized rubber, aging and weathering tests, low-temperature tests, automotive and aeronautical rubber, packing and gasket materials, hose and belting, tape, electrical protective equipment, coated fabrics, insulated wire and cable, hard rubber, rubber adhesives, crude rubber, rubber latex, synthetic elastomers, compounding materials, nonrigid plastics, electrical tests, nomenclature and definitions, and general test methods.

ASTM Standards on Rubber and Rubber-Like Materials; 890 pages; paper cover; price $8.50; to members, $6.80.

Compilation of ASTM Standards in Building Codes

This volume, containing over 200 standards in their latest form, is a completely new edition of the compilation of ASTM standards found in building codes first published in 1955. It includes 18 standards not previously included in the original 1955 edition or its 1956 supplement.

Building codes throughout the United States and Canada have adopted, by reference, a large number of ASTM standards as authentic criteria of quality and established procedures for building materials and constructions. This compilation includes ASTM standards that are referenced in such nationally known codes as the Basic Building Code, Building Officials Conference of America; Southern Standard Building Code, Southern Building Code Congress; Uniform Building Code, International Conference of Building Officials; and the National Building Code of Canada.

Ordinarily these standards are scattered among the several volumes of the Book of ASTM Standards; therefore, in combining all such reference standards under one cover, this compilation should perform a valuable service for those interested in all types of building materials. It is believed that this compilation will be useful to state and municipal agencies concerned with the effective administration of building codes, to architects, specification writers, engineers, and inspection personnel.

Compilation of ASTM Standards in Building Codes; 1080 pages; paper cover; price $8.00; to members, $6.40.

Citations for Quality of Presentation

60th Annual Meeting—1957

Carl A. Menzel

Velmer A. Fassel

E. J. Eckert

APART from maintaining the technical quality of all papers presented at meetings of the Society, the Administrative Committee on Papers and Publications is also interested in having these papers well presented. Much emphasis is being placed currently on the importance of communication. This is found to be particularly significant in conveying ideas or concepts for dealing in technical developments.

With this in mind and also with the view of improving the interest at technical sessions the plan was instituted of grading the character of presentation on the part of the authors. Reporters were assigned the task of reporting in detail on the character of presentation of all of the papers at the 1957 Annual Meeting. Based upon these reports, the three outstanding presentations for 1957 have been selected and recognition is being accorded these three individuals:

Carl A. Menzel, consultant, concrete technical problems, Portland Cement Assn., Chicago, Ill., for presentation of his paper on "Fallacies in the Current Per Cent of Total Absorption Method for Determining and Limiting the Moisture Content of Concrete Block."

Velmer A. Fassel, professor, Institute for Atomic Research and Department of Chemistry, Iowa State College, Ames, Iowa, for presentation of his paper on "Emission Spectrometric Determination of Oxygen in Metals."

E. J. Eckert, supervising engineer, Research Department, Caterpillar Tractor Co., Peoria, Ill., for presentation of his paper on "Torsion Fatigue Testing of Axle Shafts."

District Activities

WESTERN N. Y.—ONTARIO

Student Award Program Initiated

The Western New York-Ontario District initiated its student award program with the presentation of 45 student membership certificates to scholars from six schools. The awards were made in recognition of scholastic achievement or a displayed interest in knowledge of materials and were presented to the students by ASTM Vice-President F. L. LaQue, The International Nickel Co. Presiding over the ceremonies was Clarence Lamoreaux, The Buffalo Slag Co., chairman of the District.

Nickel in Ample Supply

Mr. LaQue gave an illustrated lecture on Nickel. Graphically showing the supply and demand for the metal, Mr. LaQue went on to discuss the exploration and mining of the metal, particularly in the ore fields in Manitoba, Canada. Predicting that ample supplies of nickel will be available for many years, he felt that the major problem is to expand the applications of this metal, utilizing its particular metallurgical and chemical properties.

PITTSBURGH

Eight Student Awards Presented

Continuing a precedent of long standing, the Pittsburgh District held its annual Presidential-Student Award Night on Wednesday, April 30, at the University Club in Pittsburgh. A dinner for the student awardees and their professors and honored guests of the Council was held prior to the meeting. Hugh Beeghly, chairman of the District, presided. Among those attending was F. M. Speller, honorary member of the Society, who has been associated with ASTM activities for over 50 years.

ASTM President Kropf presented student awards of a year's membership in ASTM in recognition of scholastic achievement or interest in and knowledge of materials at Pittsburgh's annual Presidential-Student Award Night. These awards serve to introduce ASTM to outstanding students in the scientific and engineering fields. The awardees were presented to the President by members of the Council who acted as sponsors for the students.

The students receiving the awards were: Florian L. Bechtold, and John W. Wesner, Jr., Carnegie Institute of Technology; Paul H. Dehoff and William A. Dunn, Pennsylvania State University; Elmer L. Murphy, Jr., Albert R. Zimmerman, West Virginia University; and George W. Sowinski and John J. Diulus, University of Pittsburgh.

Mr. Kropf briefly addressed the gathering of nearly 80 members and guests on the future of technology. After reviewing some significant historical events he predicted that the U. S. will be woefully short of engineers and scientists unless a program is devised now to meet the demands of 1975 and thereafter. A social hour followed the President's address.

PHILADELPHIA

The Consumer Demands, Automation Demands Total Quality Control

Insistence by the consumer on quality characteristics and the exacting requirements of automation are forcing industry to re-evaluate quality control programs to meet stricter requirements within a framework of economical costs, according to A. V. Feigenbaum, manager of quality control services for the General Electric Co. Any hope that automation will alleviate quality control demands is foredoomed. Actually, automation increases the need.

The examples are many: on the one hand, the automatic subassembly machine that is down more than it is in operation because a 1 per cent reject level is not good enough to keep defective components from jamming the hopper track feeding the machine 14 times an hour; on the other hand, the industrial control product that simply can't be assembled unless all the parts are right.

When we add these examples together, we find emerging the true nature of the quality problem under automation. It is that, unless the 'make it right the first time' total quality control planning principle is really made to work, there will be no automatic production. Machine downtime will see to that. It is that, as compared with today's hand operations, the automation of the future will require far better quality control engineering systems for determining the quality-ability of new designs prior to the start of production; it will require far tighter process controls over incoming material quality and over in-process quality; it will require the design and development of far more effective inspection and test measuring devices of the feedback control variety; therefore, it will, in summary, require the development and use of far higher levels of total quality control technology.

Consumer insistence on quality in the products purchased is increasing.

No less an authority than Mr. Lawrence A. Appley, president of the American Management Assn., refers to the possibility that we are in the midst of what he calls a consumer "quality strike"—that, increasingly, imperfections in delivered goods that are high in price and supposedly high in quality are straining the patience of consumers.

Year by year and whether housewife or corporation, the consumer has been asking for progressively higher levels of product quality. In a recession period such as this, where belt tightening is going on and where frills may be sacrificed for basic value, this consumer demand for quality is greatly accelerated. A major influence on the consumer's willingness to buy is his expectation that he is getting full value per price dollar—which is, after all, the practical definition of product quality.

Because of the rising cost of quality control, failure to have an adequate program will probably result in the failure of the company.

Quality control, it was emphasized, is not the sole responsibility of any one department. It is a thread that weaves its way through all levels of engineering, production, marketing, and shipping, but it is not sufficient to leave it entirely in their hands. To buttress an over-all quality control program an organization must be established "whose only area of specialization is product quality, whose only area of operation is in the quality control jobs, and whose only responsibilities are to be sure that the products shipped are right—and at the right quality cost."

The coffee speaker, Bobby Thomason, former quarterback of the Philadelphia Eagles and currently a civil engineer, discussed some of the problems associated with pro football. He was introduced by Tinius Olsen, III, chairman of ASTM Philadelphia District.

J. B. Kopec, vice-chairman of the Delaware Valley Chapter of the American Society for Metals, presided at this Joint ASTM-ASM meeting, Wednesday, May 21, at the Hotel Hildebrecht in Trenton, N. J. Members of the Trenton and Philadelphia sections of the American Society for Quality Control were also invited to attend.

Technical Committee Notes

Glass

Flame Photometry May Replace Wet Analysis

Flame photometric methods for analysis of soda, lime, and magnesia in glass were reviewed at the meeting of Committee C-14 on Glass and Glass Products in Pittsburgh on April 20. These quantitative procedures, which represent considerable saving in time over wet analysis, will be developed along with colorimetric procedures for determining magnesia and zirconia in glass.

An alternate polariscope method for the examination of strain in glass containers is being developed for inclusion in Method C 148. The interlaboratory test program on a standard set of strained and annealed specimens has been completed and the data are being analyzed prior to presentation to the committee.

Liaison is being maintained with the U. S. Pharmacopoeia and pharamaceutical houses on methods of testing pharmaceutical glass bottles.

Casein

Particle-Size Measurement Added to Test Program

Committee D-25 on Casein and Similar Protein Materials, at its meeting of June 18 in Lancaster, Pa., reviewed a method of sampling bulk shipments of casein and methods of determining the nitrogen content and moisture content of casein. These methods will be sent to subcommittee for ballot.

Methods which are in various stages of preparation include tests for total fat, oil, ash, fixed ash, free acidity, and alkali requirements of casein and soya protein. Interlaboratory collaborative test programs are being initiated for determining viscosity of casein solutions using the Brookfield viscometer, insoluble matter, dirt content, foaming characteristics, odor, minimum alkali requirements for solution, and a method of measuring the adhesive strength of the casein solution. A second interlaboratory collaborative test program is being carried out to establish a method for determining particle size of the raw casein. Anyone interested in participating in these interlaboratory tests are urged to contact the Secretary of the committee, L. E. Georgevits.

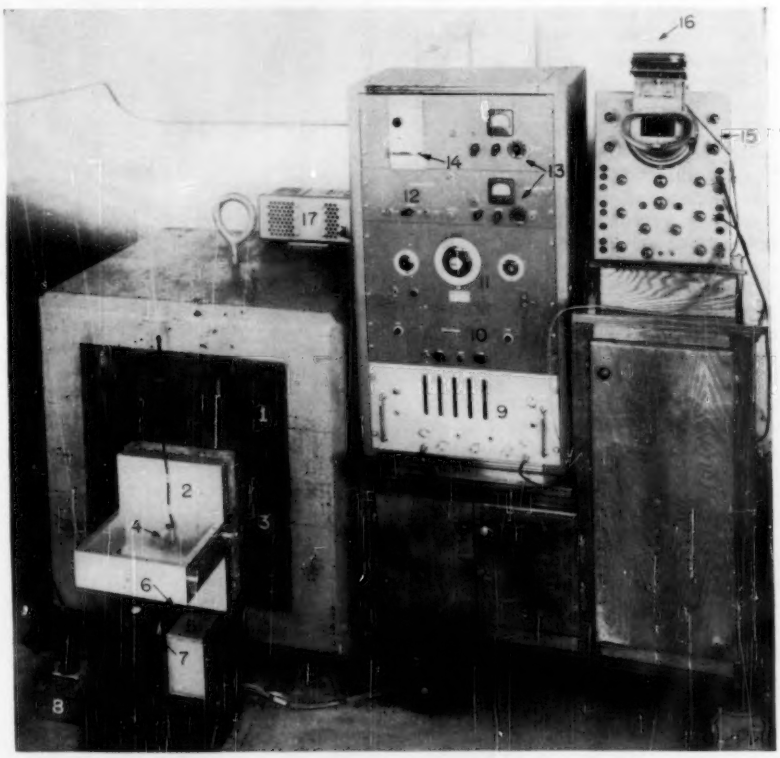
Shipping Containers

Dynamic Properties of Package Cushioning Materials

A method of test for dynamic properties of package cushioning materials has been developed by Committee D-10 on Shipping Containers. This method, which is the culmination of three interlaboratory test programs using a variety of materials in seven laboratories, applies to those materials exhibiting a high degree of compressibility and recovery in bulk, sheet, or molded forms as used for cushioning packaged articles. The test apparatus consists of a machine having a dropping head and anvil for dynamic loading of a cushion simulating impact received in rough handling. The picture shows the recording components in which a transducer is mounted on the dropping head so that a complete acceleration-time curve is obtained with the aid of an oscillograph or other recording devices. From this curve, properties of the cushioning materials can be obtained.

A revision of method D 1008 was presented in which the desiccant measuring the water vapor permeability of the shipping container is defined on the basis of exposed area rather than on a weight basis. The area of exposed desiccant is critical since insufficient exposed area will give low test results. A new precision and accuracy statement is based on considerable interlaboratory collaborative test exposures.

Revisions of the methods of vibration test for shipping containers were reviewed. A new release mechanism for the drop test (Method D 775) was proposed. Work is continuing on a proposed stacking test, improvements on the incline impact test (D 880), and the revolving hexagonal drum test (D 782).



Recording components used to determine acceleration-time curve for package cushioning materials. 1, Steel-concrete abutment; 2, Loading pendulum; 3, Cushioning specimen; 4, Strain-gage accelerometer; 5, Box housing photoelectric tubes; 6, Interrupter arm; 7, Light source; 8, Voltage regulator for light source; 9, Electronic counter; 10, Thyratron circuits; 11, Audio oscillator; 12, Pulse generator; 13, Junction boxes for two-channel recording system; 14, Preamplifier; 15, Dual beam cathode ray oscilloscope; 16, Land process camera; 17, Voltage stabilizer for entire recording system

Technical Societies Speed Nuclear Progress

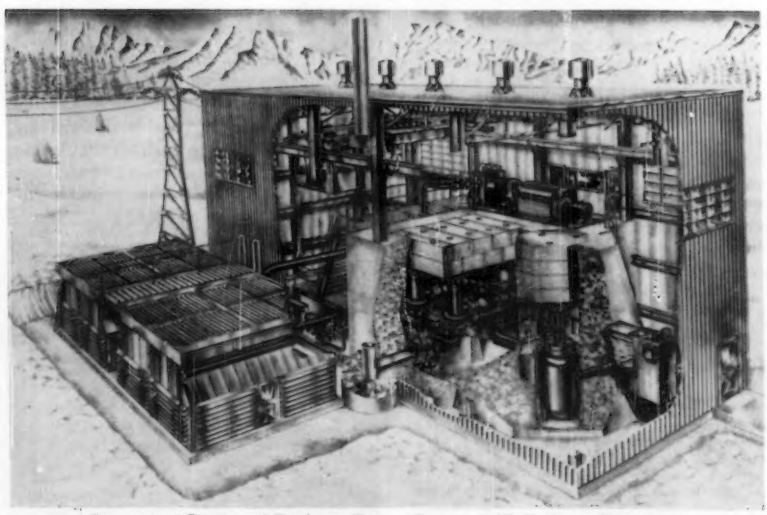
A Survey Describing Some of the Activities of Technical Societies in the Field of Nuclear Energy

TEN YEARS AGO most of the activity in the nuclear energy field was under the auspices of the United States Atomic Energy Commission. The first significant declassification of reactor information was the release, in 1951, of data pertaining to uranium and reactors in which it is used. Then, in 1953, the groundwork was prepared for bringing industry into the picture as a partner of Government. Hearings to this effect were conducted by the Joint Committee on Atomic Energy. Witnesses strongly urged that this country develop a strong civilian nuclear power program. Further declassification of information resulted, and reactor projects began to mushroom. Finally, in 1955, the Geneva Conference declassified and released more information. During this decade the philosophy underlying the development of nuclear power shifted from solely Government to private enterprise. Activity became intense. Today the question is, "Who is doing what in nuclear energy?"

This article is an attempt to supply an answer by describing some of the activities of technical societies in the nuclear energy field. It is not intended or possible to give here a complete picture of technical activity, but rather to outline some of the segments especially concerning committee work dealing with fabrication, base materials, research, test methods and processes. Only a sampling of the numerous societies is presented.

American Institute of Chemical Engineers

The Nuclear Engineering Division of the American Institute of Chemical Engineers was organized in December, 1953. It was the outgrowth of a committee on nuclear energy which was set up primarily to plan technical programs for meetings. This committee felt that the field was so important that it organized a more formal group to serve the needs of those scientists and engineers whose primary activity is in the field of nuclear engineering. The Nuclear Engineering Division, upon its formation, took over the sponsorship of the First International Congress on Nuclear Engineering held in Ann Arbor, Mich., in 1954, and it has played an active part in all of the Nuclear Congress programs since.



Conceptual Design of Package Power Reactor—U. S. Army Engineers.

The primary objectives of the Division are: (1) to provide an opportunity for engineers and scientists interested in the field of nuclear engineering to meet and discuss problems of mutual interest, (2) to promote publication and dissemination of information in this field, and (3) to promote and coordinate educational activities in nuclear engineering between Governmental agencies, industry, and academic institutions. According to the By-laws, anyone interested in promoting the objectives of the Division is eligible to join, there being no requirement of AIChE membership.

A quick glance into some of the recent activities shows the Division sponsoring six sessions of the "Fuel Cycle" at the 1957 Nuclear Congress, and 32 papers at the 1958 Congress. Numerous symposia and papers were also presented at AIChE meetings during 1957 and 1958. The Division keeps its own members informed through the distribution of a periodic news letter. On a wider scale it prints the "College Programs in Nuclear Engineering Education," publishes "Nuclear News," book reviews, and nuclear papers in the AIChE Journal and in "Chemical Engineering Progress."

The Division maintains liaison with other committees by holding membership on the ASEE Nuclear Committee, and on the ASA Nuclear Standards Board, Sectional Committee N5. In 1957 it cosponsored with ASTM and several other organizations a Symposium on Nondestructive Tests in the Nuclear Energy Field.

American Society of Civil Engineers

The ASCE has been carrying on a number of activities in recent years related to the development and utilization of nuclear energy. This work is carried out by the following four committees operating under the various divisions of the society:

1. Committee on Land Use Aspects of Applied Nuclear Energy—City Planning Division
2. Committee on Nuclear Energy—Power Division
3. Committee on Sanitary Engineering Aspects of Nuclear Energy—Sanitary Engineering Division
4. Committee to Evaluate Structural Knowledge in the Atomic Energy Field—Structural Division

Each of these committees encourages the preparation of papers and the presentation of new information at conventions and conferences. The society itself takes an active part in the Nuclear Engineering and Science Congress held each year.

American Institute of Electrical Engineers

The activities of AIEE in the nuclear energy field are centered in two committees, namely, the Nucleonic and Radiation Instrumentation Committee of the Instrumentation Division and the Nucleonics Committee of the Science and Electronics Division. The work of these committees encompasses the following major areas: nuclear machines (betatrons, cyclotrons, linear accelerators, etc.), reactor control and instrumentation, general developments in over-all reactor power plant design and economics, reactor plant operation and maintenance, safety codes, standards, radiation effects on electric insulating materials, and special requirements for electric apparatus used in nuclear power plants. A number of technical sessions for the presentation and discussion of papers on these topics are held each year in conjunction with general meetings of AIEE.

In addition to these two committees, AIEE maintains liaison representatives with the American Standards Assn. (ASA Sectional Committees N1, N3, N4, and N6) and the Atomic Industrial Forum in the area of standards, nomenclature, etc., with special emphasis on reactor instrumentation and control as related to safety considerations in the location, operation, and maintenance of nuclear power plants.

The American Institute of Electrical Engineers is one of the principal sponsors of, and participants in, the Nuclear Engineering and Science Congresses which have now been established on a permanent basis and have become a major forum for the presentation and exchange of information in the nuclear energy field. In addition to aiding in the planning of the over-all technical program of the Congress, AIEE has acted as special coordinator for the sessions of instrumentation and control.

The American Society of Mechanical Engineers

The Nuclear Engineering Division of The American Society of Mechanical Engineers was formed in 1954 as an outgrowth of the Nuclear Application Committee which was organized in 1946. The division, having full programming functions, is continually working to encourage and foster research, development and preparation of technical papers, and to enhance the interchange of ideas among engineers and technologists. It cooperates with other professional groups and societies to avoid duplication of effort and to provide recognition for outstanding achievements.

A Special Committee on Nuclear Power concerned with the formulation of codes for construction of boilers and pressure vessels in equipment assemblies used in nuclear installations was established in 1954 by the ASME Boiler and Pressure Vessel Committee. A number of ASME Code Case Interpretations, based on industry requests, have been adopted and are available from the ASME. The Sectional Committee on Code for Pressure Piping (ASA B31) and its Executive Committee have published one case dealing with piping installations and are preparing others. An Advisory Committee on Nuclear Piping has been appointed to consider possible revision of the code. A subcommittee on nondestructive testing has undertaken a comprehensive study of the inspection and testing techniques in nuclear applications. The ASME also sponsors the Sectional Committee on Reactor Safety Standards (ASA N6) which consists of a steering committee and eight subcommittees.

The Nuclear Engineering Division is currently publishing, on a continuing basis, a technical summary of reactors that are under development or construction. This information will be issued in two publications, one on Power Reactors and the other on Research and Testing Reactors. The last publication, Volume I—Power Reactors, was issued in March, 1958. Volume II is scheduled for late 1958. The "Glossary of Terms in Nuclear Science and Technology" was published in 1955 as an ASME Standard. After June 5, 1957, when ASA approval was given, it was published as an American Standard, the first glossary in the nuclear power field.

American Welding Society

About two years ago, the American Welding Society's Committee on Piping and Tubing established a Subcommittee on Nuclear Power Piping. Since that time this subcommittee reviewed a number of specifications in use by industry for nuclear power piping applications. This review showed that there was a definite need for information on the welding of piping used for any type of power reactor.

To facilitate the acquisition of information, the general problem of welding of nuclear powered piping was divided into units, and members of the subcommittee accepted the responsibility for conducting the surveys and compiling available data on each of these units. All work was done to determine those areas in which power piping for nuclear purposes might differ in its requirements from similar welding in, say, the steam power field. As a result, a preliminary report was prepared covering in detail: materials, joint design and preparation, welding procedures, qualification of welders and procedures, quality control in fabrication, and inspection.

This preliminary report is presently undergoing extensive review. A comprehensive final report is expected to be issued during the latter part of 1958.

Atomic Industrial Forum

The Atomic industrial forum was incorporated in April 1953 for the following purposes:

1. To foster and encourage the development and utilization of atomic energy,
2. To provide a forum for the resolution of problems relating to atomic energy that are of concern either to the nation, to industry, or to the public generally,
3. To promote the dissemination of knowledge and understanding relating to the development and utilization of atomic energy, and
4. To foster and encourage research and development relating to atomic energy.

Current Forum membership numbers over 500 organizations and 1700 individuals in the United States and 24 other countries, including manufacturing concerns, utilities, architect-engineers, legal firms, financial institu-

tions, labor unions, universities, consultants, research institutions, insurance companies, and government agencies.

The Forum sponsors atomic energy conferences and exhibits on a national, regional, and specialized basis both in the United States and abroad. It publishes a monthly "Memo to Members" which covers atomic energy news developments. The Forum serves as an official depository library of the AEC with current holdings of some 16,500 documents.

The Forum has working committees in the following areas:

Education
Exploration, Mining, and Processing
Financial Practices
Insurance
Legal Problems
Nuclear Instrumentation and Controls
Reactor Materials
Standards
Transportation

Of related interest is the Forum's role in the American Standards Assn.'s Nuclear Standards Board program, sponsoring N2, on General and Administrative Standards, and cosponsoring, with the National Safety Council, N7, on Radiation Protection Standards.

As problems and needs have arisen in the industry, the Forum has undertaken and published the findings of special projects. Representative of these are: (1) a review of "Financial Protection Against Atomic Hazards" prepared under Forum auspices by the Legislative Drafting Research Fund of Columbia University; (2) the "Growth Survey of the Atomic Industry —1955–1956," currently being updated by the firm of Pickard-Warren-Lowe under Forum contract; (3) under a no-fee AEC contract, a survey of "Scientific and Engineering Manpower Requirements for the Atomic Industry;" (4) a round-up of "State Activities in Atomic Energy," currently being revised and updated; (5) a review of the status of "Industrial Utilization of Radioisotopes 1946–1956"; and (6) a survey of "World Development of Atomic Energy." In addition it conducted an opinion poll of its members concerning the factors which constituted obstacles limiting atomic energy development.

The Forum has also conducted, or jointly sponsored, and published the proceedings of seminars and courses in special subject areas. Topics covered in this manner have included: (1) The New Atomic Energy Law—What It Means to Industry, (2) Zirconium Technology and Economics, (3) Liability of Manufacturers of Atomic Products, (4) Public Relations for the Atomic Industry, (5) Utilization of Nuclear Standards by State Governments, (6) Reactors Materials, (7) International Problems of the Atomic Industry, (8) Nondestructive Tests in the Nuclear Energy Field, (9) Radiation Effects on Materials, (10) Standardization and Atomic Energy, and (11) Careers in Nuclear Science and Technology.

A study is currently under way on international tort liability problems by the Harvard University Law School under Forum auspices. The Forum has also issued, and plans to continue to issue, a year-end roundup of the most important achievements of the U. S. atomic energy industry.

American Society for Testing Materials

In 1956, the ASTM Board of Directors appointed the Special Administrative Committee on Nuclear Problems, recognizing that work on materials for the nuclear energy field should be undertaken promptly. This Special Committee, composed of eleven men, is charged with the responsibility of (1) advising the some 80 standing technical committees of the Society on nuclear problems pertinent to their respective scopes; (2) stimulating the undertaking of research and standardization projects specifically related to nuclear energy, on the part of the technical committees; and (3) periodically reviewing the status of the work.

Basically, the Society will depend upon its regular committee structure to handle considerations of nuclear materials properties rather than to assign such problems to a separate committee.

The ASTM technical committee dealing with the over-all field is Committee E-10 on Radioisotopes and Radiation Effects. During 1957, its Subcommittee II on Radiation-Induced Changes in Materials has been providing well qualified speakers to tell ASTM technical committees (promulgating engineering material specifications) how nuclear radiation affects the properties of materials. Committee E-10 has also been assigned the task of establishing basic procedures for test specimen preparation, exposure to radiation, and measurements of changes due to such radiation. The first step in this undertaking has been to establish a Dosimetry Task Group to identify the problem areas in this field and to delineate the actions required to minimize these problems.

Many of the ASTM technical committees promulgating engineering material specifications are now organizing special subcommittees to handle standardization problems arising with respect to materials being used in nuclear reactors. Many others are adding specialized personnel. Committees currently involved in standardization activities are:

Committee A-1 on Steel
Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel, and Related Alloys
Committee B-2 on Non-Ferrous Metals and Alloys
Committee C-16 on Thermal Insulation
Committee C-21 on Ceramic Whitewares and Related Products
Committee D-9 on Electrical Insulation
Committee D-19 on Industrial Water
Committee D-20 on Plastics
Committee E-7 on Nondestructive Testing

Of special interest is the decision of Committee B-2 to draft specifications for zirconium and lithium. This is the result of an extensive survey of the need for industry-wide specifications for the new metals. Of all those investigated, there appeared to be sufficient information available to standardize these two.

The Society, through Committee E-10, and jointly with the Atomic Industrial Forum, is sponsoring a series of Symposia on Radiation Effects on Materials. Two of these have already been held. The papers are published by ASTM and the widespread distribution indicates the interest in this activity. The Society has also published the Symposium on Nondestructive Tests in the Nuclear Energy Field held on April 16–18, 1957. This was a joint effort with the Society for Nondestructive Testing, The American Nuclear Society, the American Institute of Chemical Engineers, and the Atomic Industrial Forum. Other symposia dealing with the effects of nuclear radiation on engineering materials are planned.

The ASTM is represented on the Nuclear Standards Board of the American Standards Assn. and on sectional committees organized under that Board. With its pre-eminent position in the materials field, the ASTM is looked to for materials standards in the nuclear field.

The ASTM is one of the joint sponsors of the Annual Nuclear Engineering and Science Congress.

Manufacturing Chemists' Assn.

The nuclear energy activities of MCA are more or less in the formative stages, but considerable expansion is anticipated in the near future. The Atomic Energy Committee of the MCA

was organized in 1955 to survey the membership of the Association on the impact of peaceful uses of atomic energy on the chemical industry. The committee was also instructed to prepare and submit a report of the findings on behalf of the association to the McKinney Panel of the Joint Congressional Committee on Atomic Energy. This report was then presented to the Panel January 3, 1956.

Since that time, the committee has operated on a semiactive basis, serving as adviser to the MCA representatives on the Nuclear Standards Board of the American Standards Association. This ASA group was formed "to consider the very broad question as to whether or not there is now a need for the development of national standards and codes under the procedures of the ASA in the field of nuclear energy."

The committee also concerns itself with miscellaneous nuclear problems affecting the chemical industry and serves as liaison between MCA and such groups as the National Research Council and the Atomic Industrial Forum. It is expected that activities of the committee will substantially broaden within the near future as a result of institution within the Association of a new activity involving manufacturers of reactive metals and ferro-alloys.

American Institute of Mining, Metallurgical, and Petroleum Engineers

In 1954, a Nuclear Metallurgy Committee was organized within the Institute of Metals Division of the AIME to promote the presentation and publication of papers dealing with the metallurgy of nuclear materials. Extensive declassification of material in the metallurgical field was just beginning at that time, and it was felt that some special effort should be made to encourage people to write and present papers in open meetings. The first tangible results were the presentation of nine papers in two sessions at the Annual Meeting of the Institute in the Spring of 1955. Since then, papers on nuclear metallurgy have become a regular and increasing part of the Institute's meeting and publication program.

It was also felt advantageous to organize symposia on selected topics in nuclear metallurgy and to publish the proceedings of these symposia as separate volumes. The first symposium was held at the Fall Meeting in 1955 and issued as Vol. 1 of the Nuclear Metallurgy Series. Since then three other symposia have been presented and published as Vols. 2, 3, and 4 of this series. The fifth is now being organized.

The Institute is represented on the Engineer's Joint Council's Atomic Energy Panel and has been active in soliciting, reviewing, and presenting papers at the Nuclear Congresses sponsored by the EJC. The Institute is also represented on the Reactor Hazards Sectional Committee N6 of the American Standards Assn.

The Future

In outlining the activities of a few technical societies we have attempted to show how, in only a few years, private industry has undertaken large and extensive research and development programs in the field of nuclear energy. Professional men and the industries are getting together on the problems involved in the economical and safe design, construction, and operation of reactors. Standards for materials and equipment for nuclear plants need study. A better understanding of the properties of steels and other metals under stress, pressure, temperature, and shock is required. Methods of inspection, effect of radiation, and greater knowledge of corrosion and fatigue are fields also being explored.

The Technical Societies are attempting to find answers to these and many other problems in the nuclear energy field. Their activities toward this objective are providing a fascinating outlook for the not too distant future.

—H. J. Stremba

Forecast of Space in AEC Test Reactors

A forecast of Atomic Energy Commission space requirements during the next five years indicates only a small amount of assistance can be expected from AEC testing facilities, according to Ira F. Zartman, chief, Engineering Physics Section, AEC Division of reactor Development. "To help meet its own requirements for testing facilities," Mr. Zartman said, "the AEC is looking to private industry for the construction and operation of test reactors in which it can purchase irradiation space."

The forum for Mr. Zartman's remarks was a session on materials testing facilities in the nuclear field, held during the Nuclear Congress and sponsored by the National Industrial Conference Board and the Atomic Industrial Forum on March 18.*

Mr. Zartman discussed the extent to which private industry has used AEC testing facilities in the past and pointed out that certain AEC research and testing facilities are available to private industry for the testing of reactor fuels, reactor materials, and components under actual reactor operating conditions. The AEC provides information on the type of space, neutron flux, and facilities available, policy for use on this space for commercial irradiations, facilities which must be provided by user, and priorities.

General Electric Co. to Complete Testing Reactor by This Fall

General Electric Co.'s Atomic Power Equipment Department will complete the construction of a reactor for the irradiation of nuclear fuels and materials in the early fall of 1958, according to a presentation by John Barnard, manager, Test Reactor Engineering Section, Atomic Power Equipment Department, General Electric Co. Mr. Barnard said that the GETR (General Electric Testing Reactor) will have a thermal neutron flux in the order of 2.4×10^{14} neutrons per sq cm per sec and will be located at G.E.'s Vallecitos Atomic Laboratory at Pleasanton, Calif.

The reactor will be used primarily for the development of fuel for the reactors designed by General Electric Co., Mr. Barnard said. He also made the following points:

Where a surplus of such irradiation space is available, the space is being offered to the Government and to potential commercial users. It is expected that the location of this reactor on the West Coast will make its use attractive to Government contractors and to members of the aircraft and petroleum industries in the Western states.

The reactor is supported by complete hot laboratory facilities and by radiochemistry and metallurgical laboratories at the Pleasanton site. In initial contacts with commercial customers, specific interest has been expressed in the use of the hot laboratory and other supporting facilities. Several foreign governments presently engaged in radiation work in U. S.–AEC reactors are desirous of doing exam-

* An over-all review of reactor construction completed and planned during 1957 is given in the ASTM BULLETIN, No. 228, Feb., 1958, p. 21.

inations of their irradiation samples in General Electric's laboratory.

To date, principally because the reactor has not yet gone into operation, contracts have not been completed for the use of such space as will be in excess of General Electric Co.'s own requirements.

Curtiss-Wright Building Swimming Pool Reactor at Quehanna, Pa.

The swimming pool type reactor constructed by the Curtiss-Wright Corp. at Quehanna, Pa., was described by Bernard J. Mezger, manager of nuclear power development, Curtiss-Wright Corp. This type of reactor is reported to cost about one-tenth that of the MTR (Materials Testing Reactor). Among the advantages of the swimming pool type is the fact that it can be placed almost anywhere and it will handle about 90 per cent of the types of research irradiations required in materials testing. The cost of the well-equipped, complete facility was reported to be about $2,500,000, and Curtiss-Wright expects to be able to do 90 per cent of its materials testing research in this reactor.

Westinghouse Testing Reactor to Operate in 1959

The Westinghouse Testing Reactor, now under construction at Waltz Mill near Pittsburgh, is scheduled for completion in the spring of 1959, according to Edmund T. Morris, Jr., manager, Westinghouse Testing Reactor, Westinghouse Electric Corp. Mr. Morris said that the WTR will operate at a power level of 20,000 kw of heat equivalent and will provide thermal flux levels between 1×10^{12} and 1.1×10^{14} neutrons per sq cm per sec.

Mr. Morris said that "since our announcement in April 1957 to proceed with construction of the WTR, we have received many inquiries from a wide variety of possible users of the reactor. The interest has ranged from simple gamma irradiations to complex in-pile experiments." He also said the following:

To summarize, our experience has been one of action based upon our best judgment of the demand for testing reactor services within our company, by the Government, and by private industry. Of these three potential users, only our own requirements are really known. The other two apparently have large estimated requirements, the detailed composition of which is not presently available to us. If the potential savings and product improvement thought to be possible through the use of nuclear irradiation are to become actualities, there must be a marked increase in the use of reactor space. The GETR and the WTR will provide industry generally with facilities not presently available in the past, but which should be sufficient for sometime to come unless there is a marked increase in demand.

Metals Testing at High and Low Temperatures

A Survey of Mechanical and Physical Testing Facilities in the United States[1]

In 1940 the ASTM-ASME Joint Committee on the Effect of Temperature on the Properties of Metals conducted a survey of high-temperature testing equipment in this country. By 1948, rapid expansion of these facilities had made the original survey obsolete and the Joint Committee undertook a revision, including low-temperature as well as high-temperature testing facilities. By 1956, it was apparent that another revision was needed and such was undertaken by the Data and Publications Panel of the Joint Committee, again including both low- and high-temperature testing facilities.

The survey was conducted by preparing a list of laboratories where such equipment might be available, and circulating a questionnaire among them. Out of approximately 750 inquiries sent out, 727 replies were received. Of these, 240 indicated that they had such equipment, and 487 stated that they did not.

During this survey it was learned that a similar survey was to be undertaken by the Titanium Metallurgical Laboratory, Battelle Memorial Institute, as part of a Department of Defense Program. Because of the similarity of these surveys, they were combined. The completed questionnaires relevant to the Joint Committee Survey are contained in Titanium Metallurgical Laboratory Report No. 70, April 30, 1957, "Survey of the Extent of Testing Facilities for the Determination of Mechanical and Physical Properties of Metals at Various Temperatures," by W. P. Achbach.

This summary of the response to this survey includes only equipment reported to be capable of use at temperatures below or above room temperature at the time of the survey.

By its nature, the results of this survey cannot be considered exhaustive, since not all laboratories were known, some did not reply, and the response of some may not include the facilities of all components.

It is recommended that inquiries for more detailed information regarding the test methods or results be addressed to the Laboratory conducting the work.

[1] Summary prepared by D. L. Newhouse for the Data and Publication Panel of the Joint Committee on the Effect of Temperature on the Properties of Metals.

Facility	Type of Test																				
	Thermal	Compression	Controlled Strain Rate	Creep	Rupture	Relaxation	Torsion	Bend	Fatigue	Combined Stress	Impact	Hardness	Thermal Conductivity	Thermal Expansion	Corrosion[a]	Damping	Modulus of Elasticity	X-ray Diffraction	Ceramics Test Equipment	Magnetic and Electrical[b]
Aerojet-General Corp.	X		X	X	X										X		X			
Agricultural and Mechanical College of Texas	X						X						X	X						
Allegheny-Ludlum Steel Corp.	X			X	X	X			X		X	X		X	X					
American Steel and Wire														X						
American Steel Foundries	X										X									
Univ. of Arkansas																		X		
Armco Steel Corp.	X	X		X	X				X		X	X		X			X			
Armour Research Foundation	X			X	X	X	X		X		X	X	X	X			X	X	X	X
Babcock and Wilcox Co.	X			X	X				X		X			X			X			
Bell Aircraft Corp.	X			X							X									
Bethlehem Steel Co.	X			X	X					X	X	X		X					X	
Blaw-Knox Co.	X										X			X	X					
Battelle Memorial Inst.	X	X	X	X	X		X	X	X		X	X	X	X			X	X		X
Bell Telephone Labs. Inc.																	X	X		
Boeing Airplane Co.	X	X		X	X			X	X		X		X	X	X			X		X
Boston Univ.	X																			
Brush Beryllium Co.	X			X			X				X								X	
California Testing Labs. Inc.	X				X															
Univ. of California																				*
Cameron Iron Works Inc.											X									
The Catholic Univ. of America				X																
Chapman Valve Mfg. Co.	X				X	X					X	X		X			X			
Chase Brass and Copper Co.	X			X	X				X		X									
Chance Vought Aircraft, Inc.	X	X	X		X				X								X			
Climax Molybdenum Co. of Michigan	X		X					X			X	X		X						
Clevite Research Center	X		X		X				X			X			X	X	X			
Crane Co.	X			X		X					X				X				X	
Frank L. Crobaugh Co.	X			X	X						X				X					
Crucible Steel Co. of America	X	X	X	X	X				X		X	X		X	X					
Curtiss-Wright Corp.	X				X				X								X			

Facility	Type of Test																						
	Thermal	Compression	Controlled Strain Rate	Creep	Rupture	Relaxation	Torsion	Bend	Fatigue	Combined Stress	Impact	Hardness	Thermal Conductivity	Thermal Expansion	Corrosion[a]	Damping	Modulus of Elasticity	X-ray Diffraction	Ceramics Test Equipment	Magnetic and Electrical[b]
University of Denver	X												X	X		X				
Wilbur B. Driver Co.	X													X	X		X			X
Edward Valves Inc.	X			X	X	X					X	X		X	X		X			
Elastic Stop Nut Corp. of America					X		X													
Elliott Co.	X				X				X		X									
Esso Research and Engineering Co.	X										X									
J. L. Finck Labs.													X						X	
Firth Sterling Inc.					X			X			X			X	X					X
Univ. of Florida	X			X	X							X		X	X					
General Electric Co.	X	X		X	X	X		X	X		X	X		X	X	X	X			X
Graver Tank and Mfg. Co., Inc.											X									
Harnischfeger Corp.											X									
Harrisburg Steel Corp.											X									
Harvey Machine Co.	X				X						X				X					
Haynes Stellite Co.	X			X	X				X		X				X				X	
Horizons Inc.					*															
Hoskins Manufacturing Co.	X							X							X					X
Indiana Steel Products Co.																				X
International Harvester Co.	X	X									X	X	X	X						
International Nickel Co., Inc.	X			X	X						X			X						
Joliet Metallurgical Labs. Inc.				X																
Univ. of Kentucky	X														X					
Lehigh Univ.	X																			
Lessells and Associates Inc.									X							X	X			
Glenn L. Martin Co.	X	X	X	X	X			X	X		X									
McDonnell Aircraft Co.	X			X	X															
Metal Control Labs. Inc.	X	X	X	X	X	X		X	X		X						X		X	
Metallurgical Engineers, Inc.	X	X						X			X	X					X			
Electro-Metallurgical Co.	X	X	X	X	X			X			X	X		X	X		X	X	X	X
Univ. of Michigan	*	*	*	*	*	*	*	*	*		*			*	*		*	*		
Univ. of Minnesota	X																			
National Advisory Committee for Aeronautics				X	X				X							X	X			*
National Bureau of Standards	X		X	X	X		X	X	X	X	X		X	X	X	X	X		X	
National Tube Div., U. S. Steel	X			X	X			X	X		X	X	X	X	X	X	X	X	X	X
Naval Research Lab.	X																			
	X		X		X	X			X							X				X
New England Materials Lab. Inc.	X	X		X	X															
New York Univ.	X			X							X		X	X			X			X
Northwestern Univ.	X															X	X	X		
Polytechnic Inst. of Brooklyn					X						X							X		
Rand Development Corp.	X	X																		
Rem Cru Titanium Inc.	X		X	X	X	X		X			X				X					
Republic Steel Corp.	X				X						X									
Reynolds Metals Co.	X		X	X	X				X						X		X			X
Ryan Aeronautical Co.	X																			
Southwestern Labs.											X									
Standard Oil Co. (Indiana)	X			X							X							X	X	
Stanford Univ.	X				X									X	X	X		X		
Stevens Univ. of Technology	X				X															
Swarthmore College	X	X															X			
Syracuse Univ. Research Inst.	X	X		X	X				X		X				X		X	X		
Univ. of Tennessee														X			X			X
Thompson Products Inc.	*	*	*		*			*	*		*						*		*	
Timken Roller Bearing Co.	*	*	*	*	*	*					*	*								
Titanium Alloy Mfg. Div., National Lead Co.	X				X			X			X	X		X	X		X	X	X	X
Titanium Metals Corp. of America	X		X	X	X			X	X		X									
Truesdail Labs. Inc.	X																			
U. S. Steel Corp.	X			X	X			X			X			X	X				X	X
U. S. Naval Engineering Experiment Station	X		X	X	X	X			X		X	X		X	X		X			
U. S. Testing Co. Inc.	X	X						X			X			X			X			
Vanadium Alloys Steel Co.	X										X	X		X						
Vanadium Corp. of America	X										X	X								
Wall Colmonoy Corp.	X	X																		
Westinghouse Electric Corp.	X	X	X	X	X				X		X						X			
Whip Mix Corp.														X						
Univ. of Wisconsin	X	X		X	X															

* Indicates equipment reported after publication of Titanium Metallurgical Laboratory Report 70 and not included therein.

[a] Including stress corrosion tests.

[b] Including magnetic permeability, electrical resistivity, or emissivity tests at elevated temperatures.

NEW TENTATIVES

(*Continued from page 37*)

EMISSION SPECTROSCOPY (E-2)

Hardness Conversion Tables for Metals (E 140 – 58)

These conversion tables present data on the relationship among Brinell hardness, diamond pyramid hardness, Rockwell hardness, and Rockwell Superficial hardness of: carbon, alloy, and tool steels; nickel and high-nickel alloys; and cartridge brass.

Definitions of Terms Relating to:

Emission Spectroscopy (E 135 – 58 T)

These definitions cover 23 of the more important terms in the field of emission spectroscopy. They are the first tentative definitions to be published in this field by the Society.

CHEMICAL ANALYSIS OF METALS (E-3)

Methods for:

Determination of Arsenic in Fire-Refined Copper (E 62 – 58 T)

This method is the first of several procedures for use in the chemical analysis of fire-refined copper to be completed for publication as tentative.

Chemical Analysis of Magnesium and Magnesium-Base Alloys (E 35 – 58 T)

These methods cover new procedures for determination of zirconium, thorium, and rare-earth elements in magnesium and magnesium-base alloys.

FIRE TESTS (E-5)

Method of Test for:

Defining Noncombustibility of Building Materials (E 136 – 58 T)

It has been felt necessary to go beyond the simple defining of the term "noncombustible" when referring to building materials by the development of a method of test which involves a procedure for the determination of noncombustibility of elementary materials, of which building materials are composed. The method also assists in identifying those materials which do not act to aid combustion or add appreciable heat to an ambient fire. It does not apply to laminated or coated materials.

NONDESTRUCTIVE TESTS (E-7)

Method for:

Wet Magnetic Particle Inspection (E 138 – 58 T)

This is a document outlining the nondestructive test procedure for inspection of metals by the wet magnetic particle method. It has been under development since the publication of Method E 109 covering inspection by the dry powder magnetic particle method.

ELECTRON-TUBE AND SEMICONDUCTOR MATERIALS (F-1)

Specification for:

Aluminum Oxide Powder (F 7 – 58 T)

Two standard fineness grades of the powder —No. 500 and 900 screen size—are specified for use as an insulating coating or an ingredient of ceramic mixtures for components of electronic devices. The material is described as "fused, ground, acid extracted, washed and screened to produce a fine powder." Water soluble ionic impurity is determined by measuring the water-extract conductivity. A sedimentation method is specified for particle-size measurement.

Bulk Quantity Measurement of Petroleum Products

THE installation of automatic tank gages, temperature equipment, and positive displacement meters is becoming widespread throughout the petroleum industry. In many cases, such equipment is being used for custody transfer and this trend will certainly increase in the years ahead. Eventually, ASTM will need to establish standard procedures for the installation, operation, and maintenance of this equipment. The problems associated with standardizing procedures provided a basis for the symposium on "Bulk Quantity Measurement" held on February 5, 1958, in the Rice Hotel in Houston, Tex., by Research Division II on Measurement and Sampling of Committee D-2 on Petroleum Products and Lubricants.

Titles and authors of the papers presented are as follows:

Application, Installation, and Maintenance of Automatic Tank Gages—George D. Robinson, Jr., Gilbert & Barker Mfg. Co., West Springfield, Mass.

Transfers Using Positive Displacement Meters—M. A. Levy, Southern Pacific Pipe Lines, Inc., Los Angeles, Calif.

Suggested Standard Procedures for Positive Displacement Meters Used in Custody Transfer Measurements—L. S. Wrightsman, Humble Pipe Line Co., Houston, Texas

Automatic Tank Gage Performance—H. E. Sims, Esso Standard Oil Co., New York, N. Y.

How Accurate Is Hand Gaging?—C. L. Peterson and E. F. Wagner, The Atlantic Refining Co., Philadelphia, Pa.

Contamination Control Techniques

Symposium on Cleaning of Electronic-Device Components and Materials—October 13-14, 1958

The electron tube industry and, more recently, the semiconductor device industry have found by long experience that in order to produce uniformly high quality electron tubes it is necessary to maintain extremely close control over the cleanliness of the tube parts throughout the entire production process. Techniques for cleaning and for measuring the amount of contamination will be discussed in a two-day symposium October 13 and 14, 1958, at the Franklin Institute in Philadelphia. Twenty-three papers have been offered by chemists, physicists and device engineers from RCA, Sylvania, Sperry Gyroscope, General Electric Co., Bell Telephone Laboratories, Westinghouse Research Laboratories, and Western Electric Co.

Topics to be discussed include the use of radiotracers; detection, removal and control of organic materials; use of mass spectrometry to evaluate the effectiveness of cleaning; control of dust and lint; use of water, detergents, and ultrasonics to control contaminants; removal of chemically combined contaminants; the preparation of high purity solvents; and effect of parts cleaning on tube performance. Several papers will be offered on the cleaning requirements for semiconductor devices.

The symposium is being sponsored by ASTM Committee F-1 on Materials for Electron Tubes and Semiconductor Devices. S. A. Standing of Raytheon is chairman of the committee, and F. J. Biondi of Bell Telephone Laboratories, who is vice-chairman of the committee, is in charge of this symposium program. The complete program for the symposium will appear in the September BULLETIN.

Those wishing to participate in the two-day symposium are requested to write to

F. J. Biondi
Bell Telephone Laboratories, Inc.
Murray Hill, N. J.

Individuals wishing to attend should make their hotel reservations as soon as possible by writing directly to the hotel of their choice.

Papers to Appear in Future Issues of the ASTM BULLETIN

Hydraulic Cement for Water Tanks and Pipe Lines—W. C. Hansen, Universal Atlas Cement Co.

New Device Tests Contraction Joint Sealers—Henry Johns, Bureau of Reclamation

Mechanical Behavior of Fiberglass Reinforced Laminates—F. J. McGarry and R. E. Chambers, Massachusetts Institute of Technology

A High Shear Rate Capillary Rheometer for Polymer Melts—E. N. Mertz and R. E. Colwell, Monsanto Chemical Co.

A Checking Device for Strain-Gage Indicators—B. D. Mills, Jr., University of Washington

Nuclear Radiation Effects on Materials—Gerald Reinsmith, U. S. Army Ordnance Corps

Tension Testing of Rubber Rings—F. L. Roth and R. D. Stiehler, National Bureau of Standards

A Comparison of Cement Strengths in Mortars and Concretes—M. A. Swayze, Lone Star Cement Corp.

Dish Shear Test for Adhesives—Summer B. Twiss and L. B. Clougherty, Chrysler Corp.

Remote Fluoroscopy in the 2 Mev Range—A. F. Wegener, Machlett Laboratories, Inc., and E. A. Burrill, High Voltage Engineering Corp.

Beam and Column Tests of Welded Steel Tubing with Design Recommendations—D. S. Wolford, Armco Steel Corp.

Actions on Standards

(*Continued from page 39*)

Tentative Method of Test for Tensile Modulus of Elasticity of Thin Plastic Sheeting (D 1530 – 58 T)

New Tentative.—This method of test is for use in determining the tensile modulus of elasticity of plastics in the form of thin sheeting (less than 0.040 in. in thickness). It is based on the use of a grip separation as a measure of extension.

Tentative Specifications and Methods of Test for Random Chopped Glass Fiber Reinforcing Mat. (D 1529 – 58 T)

New Tentative.—The random chopped glass fiber mats are for use with various resins in the production of reinforced plastics. The types of glass mat reinforcement covered by the specification are mechanically bound, low styrene solubility binder, high styrene solubility binder, and melamine binder.

Standard Method of Test for Flexural Properties of Plastics (D 790 – 49 T)

Revision.—The method has been revised to include procedures for rigid, semi-rigid, and laminated materials.

Standard Method of Test for Stiffness in Flexure of Plastics (D 747 – 50)

Revision and Reversion to Tentative.—A significance section was added and clarification changes were made on the theory of operation in the Appendix.

Standard Method of Test for Dilute Solution Viscosity of Vinyl Chloride Polymers (D 1243 – 54)

Revision and Reversion to Tentative.—An alternate procedure using cyclohexanone as a solvent has been added in order to permit the use of a less toxic solvent than nitrobenzene.

Several Important International Meetings. . .

A NUMBER of ASTM members are abroad this summer to represent the United States in meetings of the International Organization for Standardization (ISO) at Harrogate, England, held last month, and of the International Electrotechnical Commission (IEC) which is holding general meetings in Stockholm, Ludvika, and Vasteras, Sweden.

Also of international interest are meetings planned for the fall, in Philadelphia and Washington, of ISO 61 on Plastics, a feature of which will be an International Symposium on Plastics Testing and Standardization. In the fall of 1959, there will be held in Washington an International Conference on Rubber.

In all of these meetings there will be extensive participation by ASTM members. Altogether, ASTM provides representation for, or is interested in, the activities of 24 ISO technical committees. The United States member body for the ISO is the American Standards Assn.

ASTM Delegates Attend IEC Meetings on Electrical Insulation

AS PART of general meetings of the International Electrotechnical Commission held in Sweden this month, IEC Technical Committee 15 on Electrical Insulation met in Vasteras, Sweden, during the period July 8–17. Chief delegate to this meeting was A. H. Scott of the National Bureau of Standards and formerly chairman of ASTM Committee D-9 on Electrical Insulating Materials. Other members of the delegation were J. F. Dexter, Dow Chemical Co.; I. G. Easton, General Radio Co.; K. N. Mathes, General Electric Co.; J. R. Perkins, E. I. du Pont de Nemours & Co.; and George M. L. Sommerman, Westinghouse Electric Corp.

Most of the delegates are active in the work of ASTM Committee D-9 and a number of proposals under consideration in IEC 15 are based upon ASTM standards. Among the subjects currently under consideration is a method for dielectric strength of insulating materials (referred to as electric strength internationally), methods for arc tracking, for corona resistance, and for dielectric constant and loss. Also under consideration internationally are methods for classifying materials according to their performance at elevated temperatures.

U. S. participation in the work of IEC 15 is provided by Subcommittee II of Sectional Committee C59 on Electrical Insulating Materials, A. H. Scott, chairman. Dr. Scott is also adviser to the U. S. National Committee for the IEC.

ASTM Delegates Attend ISO Meetings on Coal and Coke

FOUR delegates represented the United States at the ISO 27 on Solid Mineral Fuels meeting in Harrogate, England, June 9 to 21.

The delegates were Dr. O. W. Reese (chief delegate), Illinois State Geological Survey, and chairman of ASTM Committee D-5 on Coal and Coke; R. F. Abernethy, U. S. Bureau of Mines; C. R. Montgomery, carbonization engineer, Pittston-Chenchfield Coal Sales; and C. C. Russell, manager, Gas and Coke Division, Research Group, Koppers Co.

The D-5 Advisory Committee constitutes the American group which serves in an advisory capacity to the American Standards Assn. on all ISO 27 technical matters and which organized the delegation to the Harrogate meeting.

Methods of testing and sampling coal and coke were discussed at the committee meetings. In view of the substantial exports of coal from the United States during recent years, international standards for coal are becoming of increasing significance to the American coal industry, according to an industry spokesman.

In addition to the United States, the following countries are participating in the work of ISO 27: Australia, Austria, Belgium, Canada, Denmark, Spain, France, Germany, India, Italy, Japan, Netherlands, New Zealand, Poland, Rumania, Czechoslovakia, Turkey, United Kingdom, USSR., and Yugoslavia. The United Kingdom holds the secretariat of the committee.

ASTM Delegates Attend ISO Meetings on Copper

FOUR delegates represented the United States at the ISO 26 on Copper and Copper Alloys meeting in Harrogate, England, from June 9 to 21. The responsibility for technical participation in ISO 26 is held by ASTM Committee B-5 on Copper and Copper Alloys.

The delegates were L. H. Adam, Franklin Arsenal, U. S. Army Ordnance, and secretary of Committee B-5; A. E. Beck, American Metal Co., Ltd; R. S. Pratt, Chief Plant Metallurgist, Bridgeport Brass Co.; and J. S. Smart, Research Department, American Smelting and Refining Co. G. H. Harndon, chairman of Committee B-5, is also chairman of the American Group for ISO 26.

The ISO Committee is concerned with the classification of copper and wrought copper alloys. A number of proposals are ASTM specifications and were submitted by the U. S. delegation for consideration by ISO 26.

The United States, through the American Standards Assn., holds the Secretariat of ISO 26. Other countries participating in the committee's work are: Belgium, Spain, Finland, France, Germany, India, Netherlands, Poland, Switzerland, Sweden, Czechoslovakia, Turkey, United Kingdom, and Yugoslavia.

Mr. Adam will also be a U. S. delegate to ISO 79 on Light Metals and Their Alloys for which France holds the Secretariat. Other nations participating in the committee's work are: Austria, Belgium, Canada, France, Germany, India, Italy, Netherlands, Norway, Poland, Switzerland, Sweden, Czechoslovakia, United Kingdom, and USSR.

This committee deals with problems of alloy classification and test methods for aluminum.

International Symposium on Plastics

October, 30–31, 1958

PLANS are nearing completion for an International Symposium on Plastics Testing and Standardization to be held immediately following the fall meetings of ASTM Committee D-20 on Plastics at the Benjamin Franklin Hotel in Philadelphia. The program comprises four sessions lasting through the two days, Thursday and Friday, Oct. 30–31, 1958. The symposium is sponsored by the Society on behalf of the American Group for ISO 61 on Plastics and the proceedings will be published.

The symposium is an event associated with the eighth plenary meeting of the International Organization for Standardization (ISO) Technical Committee 61 on Plastics to be held in Washington, D. C., November 3–8. C. H. Adams, Monsanto Chemical Co., chairman of the American Group is coordinating the

Philadelphia symposium and Washington meeting planning. A number of special events are being arranged for the delegates from abroad, of which 50 or more are expected.

The program for the International Symposium in Philadelphia, which has been arranged by a committee headed by A. C. Webber, E. I. du Pont de Nemours & Co., Inc., is as follows:

Session I—

How National Standards Are Achieved.
Chairman: Frank W. Reinhart, chief, Plastics Section, National Bureau of Standards.

Introduction—Admiral George F. Hussey, Jr., managing director and secretary, American Standards Assn.

Participants—Germany: To be named. Hungary: Andrew Miklovicz, deputy-chief of main department, Hungarian Office for Standardization. The Netherlands: To be named. Sweden: Walter Broberg, representing plastics department, Swedish Standardization Commission. United Kingdom: G. Weston, O.B.E., and H. M. Glass, technical director, British Standards Institution. U.S.A.: Robert Burns, executive secretary, Materials Advisory Board, National Academy of Sciences.

Summary—Robert J. Painter, executive secretary, American Society for Testing Materials.

The published summary of this session will also include papers from Belgium, Roumania, and U.S.S.R.

Session II—

Methods of Test for Engineering Properties of Plastics.

Chairman: R. Nitsche, director, Organic Materials Division, Bundesanstalt fur Materialprufung, Berlin-Dahlem, Germany. Co-chairman: Ralph K. Witt, Johns Hopkins University.

Basic Considerations on the Mechanical Properties of Molded Plastic Objects.—B. Bossu, M. Chatain, and P. Dubois, Centre d'Etude des Matieres Plastiques (CEMP), Paris, France.

Anisotropic Effects in Testing Plastics.—Hilding Högberg, Telefon Aktiebolaget and L. M. Ericsson, Stockholm, Sweden.

On the Most Suitable Shape for Plastics Materials Specimens Intended for Measurement of Their Shear Strength—Niuma Goldenberg, Mircea Arcan, and Edward Nicolau, Chemical Research Institute, Bucharest, R.P.R.

Encyclopaedia of Insulating Materials—G. de Senarclens, Swiss Insulating Works, Ltd., Breitenbach, Switzerland.

Mechanical Properties of Plastics at High Speeds of Testing—H. Warburton Hall, Ministry of Supply, London, England.

Session III—

Thermal Properties of Plastics.
Chairman: D. J. Van Wijk, Plastics Research Institute TNO, The Hague, The Netherlands. Co-chairman: Paul Willard, Chemicals and Plastics Division, Food Machinery and Chemical Corp.

Testing Flow Properties of Thermosetting and Thermoplastic Molding Compounds—C. M. von Meysenbug, Staatliche Materialprufungsanstalt, Darmstadt, Germany.

Stress-Relaxation in Polystyrene—Alexander Dobraczynski, Research Institute for Plastics, Warsaw, Poland.

The Vicat Softening Point Test Method: Correlations, Uses, and Variants—C. E. Stephenson and A. H. Willborn, Imperial Chemical Industries, Ltd., Hertfordshire, England.

Session IV—

Methods for Molecular Characterization
Chairman: George Dring, Bakelite Limited, London, England. Co-chairman: C. H. Adams, Monsanto Chemical Co.

The Determination of Accurate Molecular Weight of Macromolecules Through the Measurement of Dilute Solution Properties—Donald McIntyre, National Bureau of Standards.

The Use of Infrared Spectroscopy in Characterization of Polymer Structure—W. J. Potts, The Dow Chemical Co.

The Use of X-Ray Diffraction and Scattering in Characterization of Polymer Structure—W. O. Statton, E. I. du Pont de Nemours & Co.

Nuclear Resonance Studies of Polymer Chain Flexibility—W. P. Slichter, Bell Telephone Laboratories.

Suggestion for Classification of Macromolecular Products Based on the Correlation Between Structure and Properties of High Polymers—Dan C. Costescu, Institute for Chemical Research, Bucharest, R.P.R.

International Rubber Conference

An International Rubber Conference, sponsored jointly by the Rubber Chemistry Division of the American Chemical Society, the American Society for Testing Materials, and The American Society of Mechanical Engineers, will be held in Washington, D. C., November 8 through 13, 1959, at the Shoreham and Sheraton Park Hotels. The program will include papers in the broad fields of rubber chemistry and technology, the testing of rubber and rubber products, engineering in the rubber industry with special reference to equipment and processes, and rubber as an engineering material. A. E. Juve, ASTM Director, The B. F. Goodrich Co., is chairman of the conference committee.

Papers Solicited

The program committee is soliciting papers for the conference and has set the following deadlines:

Title of paper, name and affiliation of author(s), and time required for presentation—October 1, 1958.

Abstract of paper (250 words approximately)—January 1, 1959.

Completed manuscript (4 copies)—June 1, 1959.

All correspondence with respect to papers should be addressed to *Dr. B. S. Garvey, Jr., Chairman Program Committee, International Rubber Conference, Pennsalt Chemicals Corp., 813 Lancaster Pike, Wayne, Pa.*

Papers originating within the United States and its possessions must be sponsored by one of the three societies involved. Authors from outside the United States and its possessions are not required to be members of any of the American societies, and papers from overseas will be especially welcomed.

Suggested Conference Program

The following twelve classifications of subjects and their sub-classifications are suggested to authors wishing to contribute papers to the conference program, but these classifications are not intended to be restrictive and papers not falling directly under any of these classifications will be welcomed for consideration.

1. *Equipment and Processes in Rubber Manufacturing*
   (a) Automation
   (b) New Equipment
   (c) New Processes
2. *Elastomers as Engineering Materials*
   (a) Vibration Dampers
   (b) Sealants
   (c) Materials Handling
3. *Advances in Test Methods*
   (a) Small Scale Testing
   (b) Deterioration Tests
   (c) Tests of Dynamic Properties
   (d) Control Tests
4. *Product Testing*
   (a) Tires
   (b) Belting and Other Mechanical Products
   (c) Foam and Sponge Rubber
5. *Statistical Methods in the Rubber Industry*
   (a) In Research and Development
   (b) In Testing
   (c) In Production
6. *Nomenclature and Classification*
   (a) General Terms
   (b) Elastomers and Compounds
   (c) Processes and Products
7. *New Developments in Elastomer Reinforcement*
   (a) Carbon Blacks
   (b) Mineral Products
   (c) Resins
8. *Compounding Developments*
   (a) Vulcanization
   (b) Rubber Chemicals
   (c) Special Applications
9. *Polymers and Polymer Structure*
   (a) Stereospecific Elastomers

(b) Polyurethane Elastomers
(c) Elastomers for High Temperature Use

10. *Production of Rubber*
(a) Plantation Practices
(b) Synthetic Rubber Production
(c) Elastomer Manufacture

11. *Latex Technology and Foam Products*
(a) Dipped, Extruded, and Spread Goods
(b) Foamed Rubber
(c) Foamed Elastomers

12. *Physics and Rheology of Rubber*
(a) Viscosity and Flow Phenomena
(b) Elasticity, Time, Temperature, and Frequency Effects
(c) Optical, Electrical, and Other Physical Properties

National Conference on the Application of Electrical Insulation

Practical problems dealing with every type of proven insulation system will be discussed at the First National Conference on the Application of Electrical Insulation, to be held at Cleveland on September 3, 4, and 5, 1958. This is the first conference of this type to be held in the United States. The program was arranged by the Conference Committee under the direction of J. R. Perkins, of The Du Pont Co., general chairman, and H. H. Chapman, Jr., of Owens-Corning-Fiberglas, program chairman.

Cosponsors of the conference are the American Institute of Electrical Engineers (AIEE) and the National Electrical Manufacturers Association (NEMA). ASTM has officially endorsed the conference objectives.

Luncheon speakers will include W. V. O'Brien, vice-president and general manager, apparatus division, General Electric Co. and president of NEMA, and L. F. Hickernell, vice-president in charge of engineering, Anaconda Wire & Cable Co. and president of AIEE.

At a dinner meeting to be held on September 3, under the sponsorship of the AIEE Dielectrics Committee, the speaker will be L. J. Berberich, of Westinghouse Electric Corp., who was instrumental in the establishment of the committee and was also a leader in the movement to hold the Cleveland conference.

Concurrent sessions will be held at Cleveland, with topics divided according to equipment category, as follows: rotating equipment, transformers, controls and instrumentation, and electronics. Many kinds of insulation, such as magnet and hook-up wire, varnishes, flexible insulation, mica combinations, laminates, and liquid dielectrics will be discussed.

Each day the morning sessions will consist of papers delivered by representatives of electrical insulating materials manufacturers. In the afternoon sessions, presentations will be made by electrical equipment manufacturers. Ample time is also reserved for open forum discussions.

An additional feature of the conference will be commercial and technical exhibits by the insulation and equipment manufacturers. Most of these will illustrate topics dealt with in the conference sessions.

Composition of Petroleum Oils

Preface to Symposium Publication

By H. M. SMITH[1]

Editor's Note.—**Papers and discussions from The Symposium on Composition of Petroleum Oils are being published as ASTM *Special Technical Publication 224* (information on page 41). In the following preface to the publication, H. M. Smith, chairman of ASTM Committee D-2 on Petroleum Products and Lubricants outlines what it contains and tells about the outstanding accomplishments in the chemistry and physics of petroleum reported in its pages.**

THERE seems little doubt that the compilation of papers and discussion at the Symposium on Composition of Petroleum Oils, held under the auspices of ASTM Committee D-2 on Petroleum Products and Lubricants, in New Orleans on February 8 and 9, 1957, represents the most far-reaching and thorough covering of the general subject of the symposium that has ever been assembled. To those who can remember back to about 1925, the enormous advances in our knowledge of the less volatile liquids of petroleum are very evident. To the younger men who have entered the field in its more advanced stages, this tremendous change over the last 30 years may not be so apparent. For that reason, the writer of this preface is quoting below a paragraph written in 1927 and published in 1928:

> From the foregoing discussion of the studies on the less volatile liquids of petroleum very few definite conclusions can be made. Apparently the carbon atoms in the compounds constituting these oils are not saturated with hydrogen—about the only statement on which virtually all investigators agree. Moreover, the results shown by the research on these oils indicate that there are two predominating groups. In the group termed "saturated," for lack of a better name, the unsaturation of the carbon atom is taken up by ring formation; in the other, or the "unsaturated group," at least a part of the unsaturation is due to double-bonded side chains, bridged structure such as is exhibited by the terpenes, or open chain hydrocarbon with conjugated double bonds. The structures of these groups have never been proved and can only be surmised from the physical and chemical properties and from analysis. There is a marked difference in the properties of the two groups, and most investigators are in general agreement in correlation of these properties with the groups. In general, the saturated group, which may be supposed to consist of polynuclear naphthenic hydrocarbons, is relatively stable and inactive and is slightly soluble in organic solvents and concentrated sulfuric acid. It usually has a lower carbon-hydrogen ratio than the unsaturated group and does not unite readily with iodine and bromine. This small addition of iodine and bromine points to a ring structure as the nucleus of the unsaturated hydrocarbons. The viscosities, specific gravities, and indices of refraction have, in general, been found to be higher in the unsaturated compounds.

Compare this picture with the present situation as revealed by this symposium.

The only separative tools of consequence 30 years ago were vacuum distillation—and not high-vacuum, either—and embryonic solvent extraction. Today, distillation is still one of our most useful tools, but it has been developed to the point where it now includes high-vacuum distillation and molecular, extractive, and azeotropic distillation. Solvent extraction has been developed commercially, but it still may have potentialities in the laboratory, and the possibility of applying solvents as an analytical tool is brought out in one of the papers of this symposium. In addition to these older tools, the newer methods of adsorption on activated solids, such as silica gel and alumina, and thermal diffusion have appeared. Although there has been great development of the adsorptive technique in many directions, it is still a dynamic method that has not yet reached its ultimate development, as witnessed by the recent surge in the use of gas-liquid chromatography. A study of the papers in this symposium relating to thermal diffusion reveals that, although much progress has been made, this method is still in its infancy, but its future is very bright. Also, chemical reactions are now being used to effect separations. Such reactions as the formation of urea and thiourea complexes, sulfonation, hydrogenation, and dehydrogenation are all standard means of effecting certain types of separations in the laboratories

[1] Regional director, U. S. Bureau of Mines, Bartlesville, Okla.; chairman ASTM Committee D-2 on Petroleum Products and Lubricants.

of today. For the most part these were unknown, or at least unapplied, in the early days. Thus, giant steps have been taken in developing and using new methods of separation and, to a considerable extent, our advances have been made possible through these new means.

Thirty years ago, density, viscosity, refractive index, and molecular weight were the major physical properties used for identification purposes. Today the same properties are used, but with greater accuracy in their determination, and are applied in some entirely different ways. Additionally, many pure hydrocarbons in the boiling range considered in this symposium have been prepared, and their properties accurately determined. Thus, the twin developments of better separation methods and the availability of data for pure hydrocarbons, combined with determinations of hydrocarbon properties, have permitted excellent correlative methods to be worked out. These methods make it possible to estimate with fair accuracy both the molecular and carbon type analyses of heavier oils. These procedures are susceptible to constant improvement and extension to make happy the lot of the petroleum chemist.

Along with these advances in separative methods and procedures for determining physical properties, the use of optical and nuclear properties stepped to the front. Thus in this span of years the infrared, ultraviolet, mass, and now the nuclear magnetic resonance spectroscopic methods have been developed and applied to the study of the composition and constitution of the heavier oils. Many of these methods have a history of several years' application to the more volatile liquids and are now being applied successfully to the less volatile oils. Great improvement in their application, and in the interpretation of the results obtained by their use may be expected over the next several years.

All of the above developments have been and will continue to be, greatly aided by the preparation of pure compounds such as those made by American Petroleum Inst. Research Project 42. Chemists are just now beginning to reach the point in their studies and the development of their methods where the full importance of these pure hydrocarbons can be realized.

As a result of all these new tools and methods, it is now possible not only to determine molecular proportions of aromatics, naphthenes, and iso- and normal paraffins in a mixture, but to determine the proportion of the different types of carbon atoms present even in a single molecule containing all types of carbon atoms. Further, a beginning has been made in determining the amount and place of branching, and the type of molecular group making up the branches. All of these constitutive properties are being tied in with the physical and chemical properties that determine the application and usefulness of the oils.

Besides bringing together a comprehensive report of the state of the knowledge concerning the composition, properties, and analysis of the heavier petroleum oils, there are two other contributions from this symposium. One is the growing realization that no one method of determining the composition of these less volatile oils is self-sufficient. Rather, the trend is toward an integration of several methods, wherein each is developed to provide its particular and unique contribution, and yet each at the same time as a coordinated part of the total scheme of analysis. The petroleum chemist of the future will indeed have to be a very versatile scientist or a member of a team covering several scientific disciplines.

The second contribution of this symposium is a realization that the advancement of our comprehension of the composition and properties of the heavier oils is such that processing, product quality, and utilization can all be benefited by this knowledge. Engineering and technologic advances in these fields where the heavier oils are utilized are placing greater demands on the product in serving its intended purpose. As a corollary, products with greater specificity as regards composition and properties are required. This means that the process engineer and the products application engineer must have increased understanding of the materials with which they are dealing—in this case, the heavier oils.

This symposium has demonstrated that the petroleum chemist has kept up with technologic advances and can provide those concerned with processing and product utilization with the necessary information. Further, the analytical advance disclosed in this symposium indicates that the petroleum chemist can be expected to maintain or even improve this desirable position, where scientific facts can be used instead of empirical data.

Kunststoffe in English

The publishers of *Kunststoffe* of Munich, Germany—a leading European plastics technical journal—have announced that *Kunststoffe* will be enlarged, starting with the July, 1958, issue, by adding a supplement, "German Plastics Digest," which will contain condensed English-language translations of the most important articles appearing in the journal.

Subscriptions for the expanded magazine are $32.00 annually, and should be sent to Carl Hanser, Zeitschriftenverlag GMBH, Munich 27, Germany.

National Research Council Establishes Standing Committee on Statistics

The National Research Council has established a standing Committee on Statistics to exert leadership at the national level in the application of statistical methods more widely in industry, business, government, and the various fields of science. With the intention of including members interested in mathematical statistics, biometrics, econometrics, psychometrics, operations research, industrial statistics, and statistical problems in the physical sciences, the following individuals were appointed:

Kenneth J. Arrow, Stanford University, chairman
Frederick Mosteller, Harvard University
John W. Tukey, Princeton University
W. Allen Wallis, University of Chicago
Samuel S. Wilks, Princeton University

This committee was established at the recommendation of its predecessor, the National Research Council Committee on Applied Mathematical Statistics, which was established early in 1943 for the purpose of furnishing advice on statistical personnel and on statistical problems in research, development, and production. Under the chairmanship of L. P. Eisenhart, Professor Emeritus of Princeton University, the committee not only handled many requests for advice from universities, government agencies, and industry, but also carried out the following major tasks: (1) the promotion of statistical quality control methods in American industry; (2) a study of personnel and training problems created by the growth of applied statistics in the United States, (3) the stimulation of applications of statistical methods in the chemical industry, and (4) the expansion of applied econometric methods in American business and industry.

In its final report, submitted on June 6, 1957, the committee described the urgent need in wartime for such a group. It also pointed to the continuing demand for advisory work, particularly in science and technology. Therefore, while recommending its own discharge as a committee in the Office of the Chairman of National Research Council, the report proposed a new standing Committee on Statistics in the NRC Division of Mathematics. This new Committee on Statistics is the result of these recommendations.

ASTM and the Steel Industry

Two Case Histories

By NICHOLAS P. VEEDER

This interesting discussion, demonstrating from actual experiences in the steel industry the importance of standards to both producers and consumers and the need for evolution of standards, is adapted from an address given at the Steel Industry Luncheon of the 1958 Committee Week by Nicholas P. Veeder, President of the Granite City Steel Company

THERE are many engineering materials, but none comes even close to the carbon and alloy steels in tonnage produced or diversity of application. Steel mills and steel fabricators depend on the ASTM and other standard-setting bodies for product specifications to give reasonable assurance of service performance.

Although steel producers cannot do without standards, they often look on standards with mixed emotions. In efforts to narrow the limits of variability in steel products, more and more complicating problems are encountered. The amount of various alloys present in steel scrap varies considerably, and the identification of most of these is almost impossible in a heterogeneous pile of scrap. Mills using a high percentage of purchased scrap naturally have more difficulty in controlling these elements, but considerable variation also occurs in the iron ore and coal which are the other principal components of steelmaking. The air used is probably the only thing that does not vary too much, or at least if it does, maybe we are not quite smart enough to know about it. In any event, it is necessary to keep control of the elements mentioned.

The more rigid the specifications for a given steel product, the more necessary it is for the mill to exercise close control and supervision on the manufacture of that product, and, obviously, this becomes expensive. Depending upon the requirements, quality must be watched all the way from the coke ovens and the blast furnaces to the finished product. An identification of these products is generally an important part of the specification too, and here more careful marking and tighter requirements also mean increased costs.

However, this difficulty of producing steel products to specification is not and should not be accepted as a reason for not doing it. Specifications offer definite advantages to the user and every technological advance can make them even more essential.

The First Case History—

The Need for Evolution of Standards

The experience of the Granite City Steel Co. with specifications and standards, by and large, has been a very happy one, although some trouble is now being encountered with one product because the sampling and testing procedures, as set up by the ASTM, have not caught up with a new development in the method of manufacture.

For years plates have been rolled on a plate mill. Generally, this type of mill is a one- or two-stand device which does almost all of its work in one of these stands by reversing the product and sending it back and forth through the mill. These mills, when rolling light plate, generally start with a light slab, often as small as 2000 to 3000 lb with some ingots even as small as 1200 lb.

This type of plate production was replaced by the wide, hot strip mill. Originally, on the hot strip mill most of the work on plates was done in the roughing stands and the continuous finishing stands were used to do a minor part of the work and a good leveling job. This process did not contribute much to the efficiency, because more people were used to run the mill without processing substantially large units of slab weight. In order to get over this limitation, it was necessary to go to much longer plates—and, thus, much heavier ingots. The plates are coiled after the rolling operation instead of being kept flat at all times. This step required the installation of very heavy coilers as well as, of course, uncoilers to flatten the steel after it came from the coils, and heavy shears to side trim it and cut the plates to length after the coil had cooled off from its hot rolling.

By so doing, a 2000 to 3000-lb slab could be replaced by a 20,000 to 30,000-lb slab and rolled through the hot strip mill and coiled at the end of the run-out table. This required very careful control of finishing temperatures and cooling on the run-out table to have the necesary coiling temperature. It was absolutely essential to control all these things in order to maintain the desired physical properties of the finished product, with a given content of carbon, manganese, silicon, and other alloying elements.

Here is where we have run up against what I consider obsolete specifications for this product. Everything about these plate specifications is designed around the conventional plate mill where the product is rolled in smaller batches, smaller slabs, comes out of the mill, and is always kept flat. The taking of test specimens and the marking of these products is designed for this type of handling; the new type of handling, while much more efficient

has to be adapted to these specifications. For example, consider what this means in the case of the rolling mill. A good old-fashioned plate mill probably produces about 35 tons an hour of light plate products. Even the newest mill would probably produce only 110 tons or so—say plates $\frac{1}{4}$ in. thick by 60 or 72 in. wide. This product can be rolled by the new process at almost unlimited tonnages. In the new mill where formerly only 35 to 50 tons an hour were processed, 350 tons an hour are now rolled. So, the benefits are not imaginary. I think in the near future the specifications can be brought up to date for this type of manufacture.

The Second Case History—

The Evolution of a New Product and the Standards to Serve It

Now our experience in another product has been entirely different from the plate situation.

Just prior to World War II, I was in the Metallurgical Department of our Company doing customer contact work. One of our programs was to see if we could interest some of our customers in using full hard cold rolled steel sheets which, our research had indicated to us, had considerable potential for galvanized, corrugated roofing sheets—although the traditional method of producing these sheets included the operations of annealing and temper rolling. J. Russell Britt, the director of our Department of Metallurgy and Inspection, and I were finally able to design some dies for corrugator rolls that could shape unannealed cold rolled sheets into the desired pattern of corrugation despite their stiffness. Well, this program was no more than started than World War II came along. The country ran out of zinc; that is, all the zinc available seemed to go into cartridge cases, and we made no more galvanized sheets. This process lay dormant until after Germany surrendered when we suddenly obtained an order for galvanized sheets for quonset huts. We decided to use unannealed sheets because of their higher strength-to-weight ratio and to put the corrugator dies we had developed into use.

One hurdle that bothered us was the question whether nails could be driven through this material. We worked this out by sort of a blindfold test with annealed and unannealed sheets spread around a warehouse floor, and we all drove nails until we were satisfied that there wasn't any tremendous amount of difference between the two grades of material.

When we got the first lot of this material ready for shipment, it occurred to us that it might be well to find out if the fabricator could curve it to the desired quonset hut radius, so we sent a truck load to the company in Cincinnati that had this equipment. The superintendent of this plant said he was certain he could curve it and took the first sheets to a battery of belt-driven curving rolls. The first sheet entered the rolls and came out the other side just about as flat and straight as it went in, and, needless to say, the superintendent was quite surprised, and our men were a little shocked. However, this superintendent was not to be deterred by an extra-strong corrugated sheet, and, fortunately, a new curving roll with an individual direct drive was available. The sheets went through this curving roll satisfactorily. If the superintendent hadn't been so enterprising, that might have been the end of our product, Strongbarn.

After the war we standardized on a 29-gage sheet because it has the equivalent strength of the 26-gage conventional roofing sheet and was 33 per cent lighter in weight. It was only logical and good business in the long run to put a reasonably heavy coating of zinc on this material.

At that time there was an ASTM specification, A 93, covering all gages of steel, all coating weights and classes of galvanized sheets, including roofing. However, this specification was much too complicated to be generally understood by the roofing jobbers and others, and, to the best of my knowledge, no mill made roofing sheets to this specification as a regular procedure. This made it easy for some mills to enter the field during periods of low demand for its regular products. This entry was made profitable by making a product with a very light coating and selling it at a low price. This not only distributed the price structure for the material, but badly disrupted the reputation of galvanized sheets because the very lightly coated material rusted quickly and excessively.

The life of a galvanized coating for any given corrosion medium is almost a straightline function of the weight and thickness of the zinc coating.

Although the American Zinc Inst. had established in 1932 a grade of material called "Seal of Quality," this material with the 2-oz coating was a premium product and could be sold only in very small quantities. The vast majority of the commercial roofing sheets varied vastly in quality, and it became obvious that an ASTM standard for commercial grade roofing sheet was a real necessity in this market.

An effort was made to persuade ASTM to adopt a standard for this product. Committee A-5 on Corrosion of Iron and Steel wrote specification A 361 a few years later. This specification required a minimum coating weight of $1\frac{1}{4}$ oz per sq ft, thereby excluding from galvanizing roofing the sheets that were coated with too light a coating which had brought a bad reputation to the industry's product.

I do not think any specification ever adopted by ASTM was more widely accepted so soon. Our company alone produced over 100,000 tons of product made in accordance with this specification the first year.

This story illustrates the value to both the producer and user of an intelligently drawn ASTM specification. Specification A 361 has helped the producer by stabilizing the market, by eliminating price cutting based on poorer quality, and by helping galvanized roofing to regain its reputation of durability. It has helped the consumers by giving them an understandable way to judge the quality of commercial grade galvanized roofing sheets. From the producer's standpoint, it was carefully written so that its requirements would follow standard operating procedures at those mills that were in the galvanizing market to stay and were interesting and willing to produce a high quality product.

This specification, A 361, is, of course, only one of many hundred ASTM specifications. I have covered its origin because it illustrates the conditions that combine to make a standard both useful and successful. A standard must be needed; it must be written on a practical basis for both producers and consumers; and it must be put to use. In short, this is the story of ASTM specifications.

I wish I could do justice to the fine job that the ASTM has done and is doing. I am sure that every specification in the book has a story back of it that is equally as significant to the manufacturers and users of the products concerned as this specification, A 361, has been to us. No other specification has had so much tonnage of steel made to its requirements in so short a period of time as has A 361, but I am sure other specifications perform equally important functions in many other fields

As far as the steel industry is concerned—and I am sure it is true of other industries as well—we sometimes swear at the practical operating difficulties encountered in producing material to an ASTM specification, but we are well aware that we could not do without them. ASTM may not always be loved, but it certainly is always respected.

Creating Test Atmospheres at −260 F

By M. JOHN BROWN and GORDON V. THOMPSON

A portable laboratory cold flask which permits operation of a dry-atmosphere test chamber at temperatures as low as −260 F for about 12 hours.

A NEW portable cold flask makes it possible to test materials at dry atmosphere temperatures as low as −260 F. Using liquid nitrogen (−320 F) in conjunction with a heat exchanger, this unit is particularly useful for cyclic heating and cooling tests. It connects to any test chamber (Fig. 1).

The flask grew out of the need to test materials used with liquefied gas fuels at service temperatures as low as −270 F. The job could not be handled by either dry ice, which produces test atmospheres down to −100 F, or by mechanical refrigeration which can only go down to about −125 F.

Maximum test duration is about 12 hr, based on the rate of liquid nitrogen consumption and the need for an attendant to refill the cold flask manually.

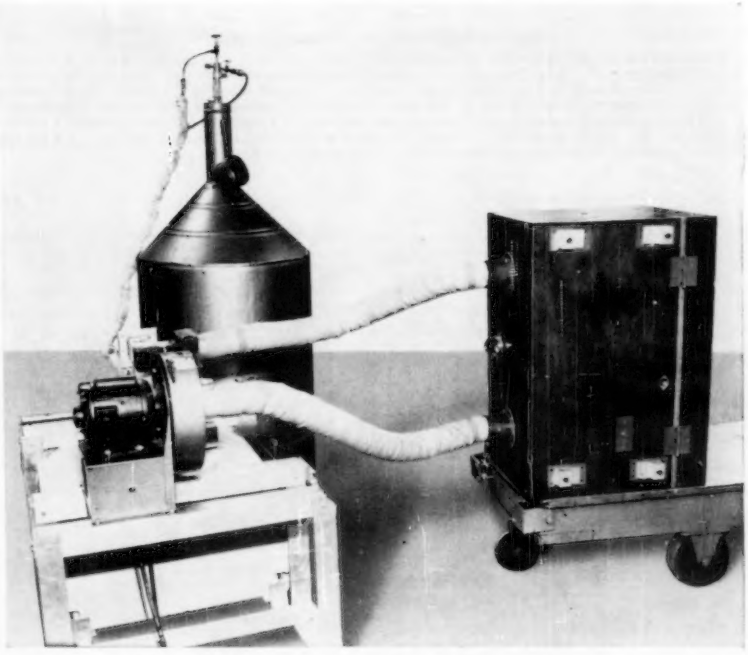


Fig. 1.—Cold flask arrangement.

Apparatus

As shown in Fig. 2, four heat-exchanger tubes are immersed in a reservoir of liquid nitrogen. Air, cooled by the heat exchanger tubes, is forced by blowers through 3-in. outside diameter flexible tubing to the test chamber, and then back to the exchanger in a continuously recirculating cycle. Cooling response is speeded by nitrogen vapors (still −320 F) which rise in the intake and combine with the cooled air. The increased volume represented by the vapors is disposed of through a vent after their cooling effect has been imparted.

The cold flask, filled with liquid nitrogen, is connected to a 9 by 14 by 25-in. Aminco test chamber by means of two 3-in. diam flexible tubes. Attached to a steel specimen in the test chamber is a copper-constantan thermocouple from which its temperature is read with a No. 8657-C Leeds & Northrup potentiometer. A slide-gate damper in the test chamber is arranged so that it partly covers the duct returning to the cold flask inlet. This damper was positioned repeatedly throughout the test to regulate the quantity of air being recirculated.

M. JOHN BROWN, Supervisor of Engineering Physical Test Laboratories, Materials Engineering, Martin—Baltimore. He was instrumental in organizing Engineering Test Laboratories and currently directs its mechanical and physical testing activities, evaluation of thermal, fatigue, creep, and static properties. Now actively engaged in developing test methods and facilities for simulating thermal-load shock and rapid heating-cooling environments. Background in structures analysis includes several years with Chance Vought Aircraft.

GORDON V. THOMPSON, Structures Engineer, Materials Engineering, Martin—Baltimore. He is in charge of Thermal Properties Laboratory for experimental design of aircraft heated structures. Background in field of heat transfer includes several years as Service Engineer for Combustion Engineering, Inc., New York, with assignments in its Kreisinger Development and Metallurgical Research Laboratories at Chattanooga.

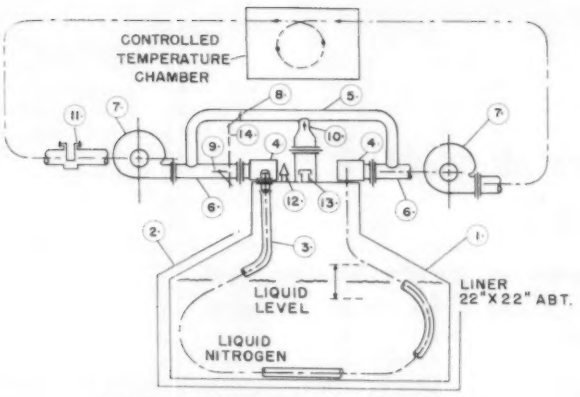


Fig. 2.—Cold flask and modulating control.

Four heat exchanger tubes (*3*) are suspended in the cold flask and interconnected for parallel flow by headers (*4*). A by-pass duct (*5*) connecting the inlet and outlet ducts (*6*) provides an alternate path around the heat exchanger section. Pressure blowers (*7*) force the air through the heat exchanger tubes and on to the test chamber. Control link (*14*) connecting dampers (*8* and *9*) regulates the proportion of air to be by-passed. Damper (*10*) can be used to shut off the flow of the vapors given off. A vent (*12*) and a filler pipe (*13*) are included. A cold trap (*11*) in the inlet duct prevents moisture from entering the cold flask.

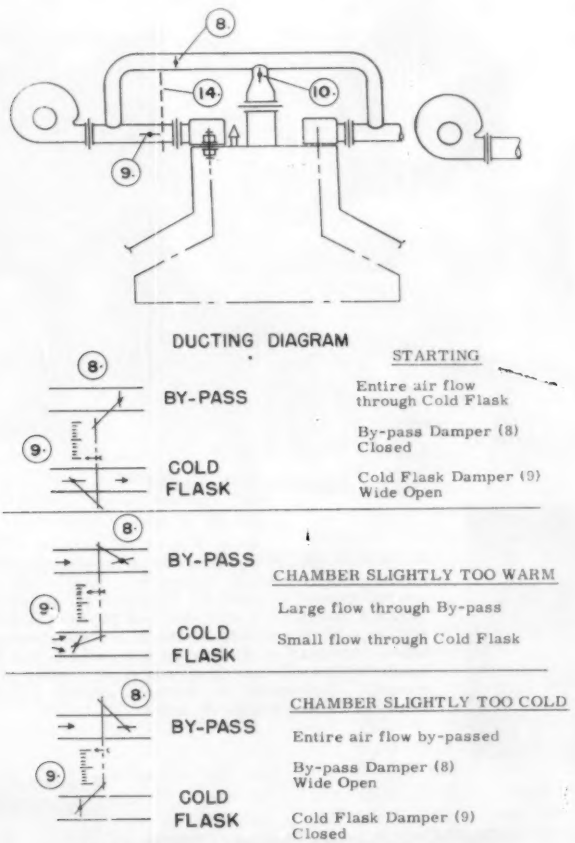


Fig. 3.—By-pass damper and modulating control.

The design provides for modulating controls to regulate the load at any increment between zero and maximum cooling (see Fig. 3). A damper in the cold flask acts in complementary fashion with a by-pass damper. To increase temperature, the cold flask damper is closed by the desired amount, restricting air flow through the heat exchanger. The same action opens the by-pass damper by a corresponding amount, permitting more of the recirculating air to

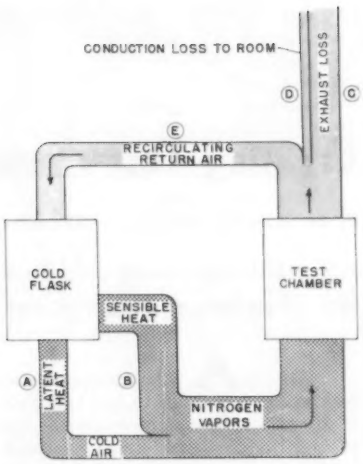


Fig. 4.—Cold flask cooling cycle.

Upon demand for additional cooling, cold air is recirculated (*A* and *E*) between the cold flask and test chamber. Returning to the cold flask, the air passes through the heat exchanger tubes and is cooled by the liquid nitrogen (−320 F). Nitrogen vapors (still −320 F) mix with the cold air leaving the cold flask (band *A*), further lowering the temperature of the air going to the test chamber. The volume added by the vapors is removed at vent (*C*) after the cooled mass has passed through the chamber.

detour around the heat exchanger tubes by way of the by-pass duct. The process is reversed to reduce temperature.

With the damper 85 per cent closed, the specimen temperature reached −150 F 5 min after the blower was turned on. The damper was moved to 95 per cent closed, and 15 min later the specimen reached −200 F. Even with the damper fully closed, the temperature held at −205 F, and with the blower turned off, the temperature stabilized at −159 F. This indicates that, even without using the blower, the vapors coming off the cold flask are enough to maintain the test chamber at about −150 F.

Figure 4 illustrates the principle involved. The heat leaking through the cold flask insulation continues to evaporate some liquid nitrogen even though the damper is closed and the blower turned off. This vapor alone, apparently, is adequate to maintain the test temperature at −150 F once the test chamber has been thoroughly cooled.

The test also sought to determine the lowest temperature attainable with the cold flask. With the blower on, the damper was opened in steps until the test temperature reached −267 F. (See Fig. 5 and Table I.) Figure 4 helps explain the action of the cold flask at low test temperatures.

Control was maintained throughout the test by restricting the return flow of

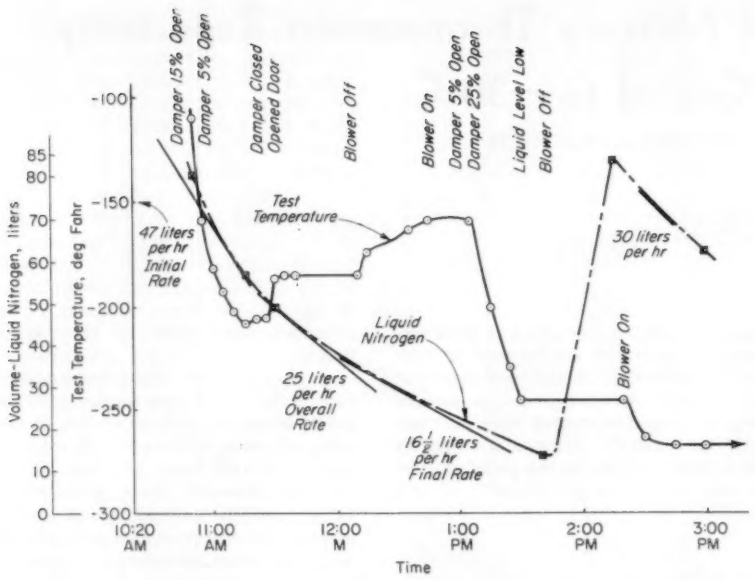


Fig. 5—Test temperature *versus* time, also showing liquid nitrogen consumption and damper positions.

air to the cold flask. There were some difficulties. Small restrictions in air flow were largely overcome by the increase in pressure caused by the restriction. Being in the test chamber, the damper could not be adjusted unless an access port was opened. The resulting temperature upset sometimes was greater than the desired change.

It is recommended that a variable-speed motor be used with the blower to permit adjustment of the recirculation rates in proportion to the demand for cooling.

TABLE I.—COLD FLASK QUALIFICATION DATA.

Time	Temp, deg Fahr	Liquid Level	Damper Position	Comments
10:30 A.M.	−16	Filling		Blower off. Vapors venting through test chamber
10:40	−40	Filling		Blower off
10:50	−110	13½ in.	15 per cent open	Blower on
10:55	−158		5 per cent open	Economy visibly improved
11:00	−181		5 per cent open	
11:05	−191		5 per cent open	
11:10	−202		5 per cent open	
11:15	−208	7¾ in.	Closed	
11:20	−205		Closed	
11:25	−205		Closed	Open door to examine damper
11:30	−185	6¾ in.	Closed	
11:35	−184	6¾ in.	Closed	
11:40	−184		Closed	
12:10 P.M.	−184		Closed	Blower off
12:15	−173		Closed	Blower off
12:35	−163		Closed	Blower off
12:45	−159		Closed	Blower off
12:50			Closed	Blower on
1:00			5 per cent open	Blower on
1:05	−159		25 per cent open	Rapid temperature drop
1:15	−200		25 per cent open	Noticeable drop in refrigeration effect
1:25	−229		25 per cent open	
1:30	−244	2 in.	25 per cent open	
				Blower turned off to refill cold flask
2:15		16½ in. (full)	5 per cent open	Blower on
2:20	−245		10 per cent open	Blower on
2:30	−263		30 per cent open	
2:45	−267		30 per cent open	Very little vapor being evolved
3:00	−267	8½ in.	30 per cent open	Exhaust plume from test chamber weak

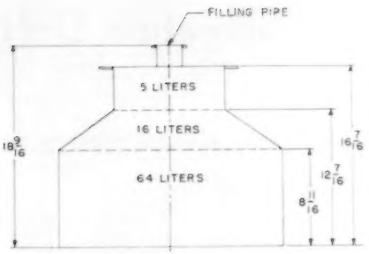


Fig. 6.—Cold flask capacity.

Tests showed, however, that losses in the system at reduced temperatures are sufficient to provide stability, and control is not a serious problem. Consequently, all refinements contributing to control at the expense of cooling effect were removed. Dampers were set and their shafts sealed. Manifolds were simplified and shortened.

As a result the air always carries maximum cooling effect. Its flow out of the test chamber is controlled, however, by a movable plate in the chamber.

Economy

Liquid nitrogen consumption was calculated from liquid level readings taken during tests (see Fig. 5). The over-all hourly consumption rate was 25 liters, or $10 per hour at prevailing commercial prices. Consumption is greatest after filling and declines after the charge drops below 50 liters. Figure 6 shows significantly that the first 8 in. of liquid level contains nearly 60 liters of liquid nitrogen, but there are only 25 liters in the next 8 in. The surface-to-mass ratio for the lower 8 in. of liquid is much less than for any volume above 8 in. In can be seen that the expected losses are much greater at the top of the cold flask than at the bottom. It is therefore recommended that the liquid level in the cold flask be held to 8½ in. as a means of limiting the consumption of liquid nitrogen to less than 20 liters per hour.

If low-temperature testing becomes a regular operation, the cost of liquid nitrogen can be cut to one third of the market cost by the use of a commercial generator. Pressurization of the cold flask would make all nitrogen vapors pass to the test chamber before being vented. Leakage at the filler pipe can be eliminated by an inexpensive automobile radiator cap.

The next step in the evolution of low-temperature heat exchangers will be a plate-type liquid nitrogen evaporator in the test chamber itself.

Calibration Drift of Mercury Thermometers Repeatedly Cooled to −30 C

By WILLIAM I. MARTIN, SIDNEY S. GROSSMAN, and J. J. McGOVERN

A systematic study has been made of the changes in calibration corrections of thermometers repeatedly cooled to −30 C and a comparison made with the behavior of thermometers cooled to this temperature only once every other day. Results indicated that calibration corrections of thermometers in constant use underwent continuous positive change in the order of +0.16 C over the period of seven months studied while the comparison thermometer correction values changed about +0.02 C. The rate of change in calibration correction values showed no indication of leveling off during this period of time, and the changes were found to be permanent.

It is generally accepted that mercury-in-glass thermometers change with time and use and that temporary changes in bulb volume are fairly regular and predictable if the thermometer is not heated above 150 C. Above this temperature the changes in the bulb volume of a thermometer are somewhat erratic and therefore not predictable (1).[1] Where the temperatures do not exceed 150 C, the expansion of the thermometer bulb with the slow return to original condition is the stated cause of such temporary "depression" of temperature readings, while flow of the glass itself is the accepted cause of long-term changes.

In the freezing point determination of purity of styrene monomer, the thermometers are never subjected to temperatures greater than room temperature (about 20 to 30 C) while in general they are used to measure temperatures in the −30 C range. Previous experience in the laboratory indicated that the calibration correction values of these thermometers were actually changing. A study was therefore initiated in an effort to ascertain changes in calibration corrections in thermometers with time and cyclical usage between the temperature of the freezing point of styrene monomer about −30.7 C, and room temperature by comparing little used thermometers with thermometers in daily use.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

[2] Method of Test for Measurement of Freezing Points of High-Purity Compounds for Evaluation of Purity (D 1015 – 55), 1955 Book of ASTM Standards, Part 5, p. 465.

Experimental

In routine plant control of the purity of styrene monomer, an analytical method based on the freezing temperature of the styrene sample is commonly used (3,6). The recommended thermometer for this determination is a total immersion, nitrogen filled, mercury-in-glass thermometer with a range of −33.02 to −29.98 C in subdivisions of 0.02 C and an auxiliary scale from −0.2 to +0.2 C. An expansion chamber permits heating to a temperature of at least 50 C. To obtain significant purity values, it is necessary that the thermometers be accurate to the closest 0.01 C.

As part of a continuous thermometer standardization program, the freezing points of selected samples of styrene are obtained using a National Bureau of Standard's calibrated platinum resistance thermometer along with standardized ASTM procedures and equipment.[2] This "standard" styrene is then used in the plant laboratory as a means of calibration of mercury in glass thermometers as well as including any differences due to equipment and technique. In other words, one correction is applied to a freezing point value which brings the obtained value in line with the "true freezing point." "True freezing point" is assumed throughout this work to be the value obtained with the platinum resistance thermometer following ASTM Method D 1015 – 55.[2] For the purposes of measuring changes in calibration, it is not necessary to have absolutely true values, but it is sufficient that they be precise and stable.

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The freezing point values obtained on a "standard" styrene sample using the platinum resistance thermometer were rounded off to the nearest 0.01 C in order to obtain the "true" freezing point. At the end of a month, another set of determinations was made in order to ascertain if any changes had taken place in the "standard" styrene sample. In every case the "true" freezing point was reproducible to the nearest 0.01 C. A fresh sample of styrene was taken and standardized every month in order to avoid possible complications due to aging of the "standard" styrene sample.

Six freezing point thermometers were used in this study, three being in constant usage and three being kept out of use on the shelf. A thermometer in active service was lowered from room temperature to about −30 C for a measurement and then allowed to stand at room temperature until the next measurement was made. Shelf thermometers were stored at room temperature.

Calibration of all six thermometers was done on an every-other-day basis obtaining a single correction value. A statistical analysis was made on 79 values obtained during the first five months of the study. One each of the shelf and daily usage thermometers was broken in the course of this study; therefore, only the data from four thermometers are reported.

Results and Analysis

Figure 1 is a plot of correction values (experimental value minus "true" value) obtained for each calibration day (every other calendar day). The fairly rapid change of correction value for the daily use thermometers as compared to the small change in shelf thermometers was of interest. The plot indicated that the change was continuous, and therefore the statistical least squares regression technique using orthogonal polynomials (2,4) was applied to the data in order to obtain an equation for the best fitting curve through the calibration correction values. At the same time a measure of the experimental variation was obtained. The following equations were found:

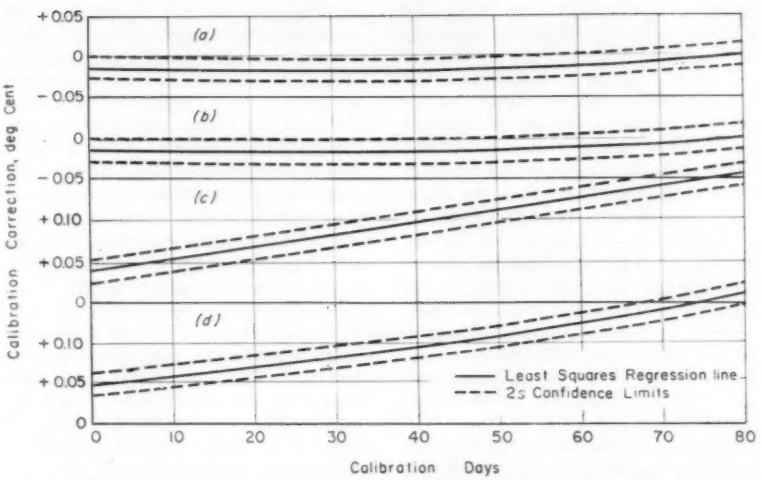

Fig. 1.—Thermometer calibration correction values *versus* calibration days (alternate calendar days).

(*a*) Shelf Thermometer No. 353990.
(*b*) Shelf Thermometer No. 353987.
(*c*) Daily Use Thermometer No. 381184.
(*d*) Daily Use Thermometer No. 381168.

Thermometer	Use	Best Fitting Curve	Standard Deviation	$\pm 2s$ Confidence Limits
No. 353990	Shelf	$CC = -0.0127 - 0.0004025X + 6.771 \times 10^{-6}X^2$	0.0065	0.013
No. 353987	Shelf	$CC = -0.0151 - 0.0002126X + 4.842 \times 10^{-6}X^2$	0.0070	0.014
No. 381184	Daily	$CC = 0.0385 + 0.001432X$	0.0071	0.014
No. 381168	Daily	$CC = 0.0503 + 0.00820X + 7.331 \times 10^{-6}X^2$	0.0077	0.015

where CC is the calibration correction value and X are alternate days numbered from 1 to 79 through the 5-month period.

The best fitting curves have been drawn on Fig. 1 along with the $2s$ limits about the curves. In general, rounding off to the closest 0.01 C indicates that the precision of an individual measurement is ±0.02 C which would include more than 95 per cent of the data.

The over-all change in correction values for the two shelf thermometers was in the order of + 0.02 C while the thermometers in daily use changed in calibration correction values by about +0.11 C during the 5-month period. It was hoped that examination of the thermometers could be continued in order to see if there would be a leveling off of the calibration correction values of the daily use thermometers and then further statistical analysis undertaken. Unfortunately, these thermometers lasted only another two months prior to breakage. If one considers that each thermometer was used about 10 to 15 times daily by all laboratory personnel, it is interesting that they were in use as long as seven months.

At the time of breakage, the daily use thermometer calibration corrections were about +0.20 C for an over-all change of 0.16 C in correction from the inception of the study without any sign of leveling off occurring. The shelf thermometers at the end of the seven months had still only changed about +0.02 C. Since no variation was seen to exist between these results and those found for the first five months, no effort was made to include the additional data in the original statistical analysis.

Discussion

The change of calibration correction with time of the shelf thermometers seems to be quite small, +0.02 C. The obtaining of a "depression" (requiring a positive correction) in thermometers with aging is usually not expected, since normally a thermometer bulb contracts very slowly with aging which results in high readings. However, in some instances the bulb may expand and read low.[3,4] It is felt that in this work the slight changes in calibration correction values in the shelf thermometers are not due to aging but rather due to the usage (about 80 measurements) given these thermometers during the 5-month calibration period. This is based on the knowledge that the thermometers were not new but over a year old prior to inception of this study and should therefore be thoroughly aged.

It was decided after checking for and finding no mechanical failure, such as splitting of the mercury column or gas bubble formation, that the large change in calibration correction for daily use thermometers could only be attributed to constant cyclical usage. The cause of the change of calibration correction with usage could be the result of one of the following: (*a*) Diffusion of gas into the

[3] Specification for ASTM Thermometers (E 1 – 56), 1956 Supplement to Book of ASTM Standards, Part 5, p. 209.

[4] Tentative Method of Testing and Standardization of Etched-Stem Liquid-in-Glass Thermometers (E 77 – 56 T), 1956 Supplement to Book of ASTM Standards, Part 5, p. 260.

capillary, (*b*) Changes in the volume of mercury, or (*c*) Changes in thermometer bulb or capillary size.

Since the change in calibration correction is fairly rapid and does not occur for shelf thermometers, the diffusion of gas into the capillary seems unlikely. Likewise, in the temperature range of the thermometer from 25 C to about −36 C, significant vapor and liquid mercury interchanges should not be encountered. Also, although the lowest temperatures involved are near the freezing temperature of mercury (−38.87 C), the literature indicates that mercury has a linear coefficient of contraction down to its freezing temperature; further, mercury contracts on solidification (**5**).

It might be possible to explain this phenomenon using the −30 C mark as a point of reference. One could then postulate that as the thermometer heats up to room temperature, the glass expands and then does not contract rapidly on cooling, thereby giving a "depression" or positive correction. This effect has previously been reported for heating of thermometers from 0 to 100 C (**1**) and is considered temporary in nature.

The fact still remains that this phenomenon seems to be additive, and when last tested, prior to the thermometers breaking, there was no indication of a leveling off of the change in correction factor. One would have to therefore further postulate that the effect is additive and that insufficient time is allowed for the thermometer to fully contract during the testing period prior to the expansion on return to room temperature. This newer volume would then be larger than the original value. On subsequent cooling and heating, the volume of the bulb would be increasingly greater requiring larger positive corrections. However, the thermometers having calibration corrections which had risen to about +0.17 C were taken out of daily usage and permitted to remain idle on the shelf for a period of one month. At the end of this period the thermometer calibration corrections were found to have remained constant, indicating that the continuous change in calibration correction is permanent and not temporary in nature. In the past, thermometers with less positive calibration corrections have been taken out of use and have likewise not returned to their original volumes as indicated by no change in calibration correction values.

The results for only a few thermometers have been given in this report, but the behavior reported has been observed in all of the thermometers used in the laboratory for the determination of styrene freezing point. It is unfortunate (due to breakage) that the work could not have been continued to ascertain how large the correction values would have been after a year or more.

Conclusions

Results of a systematic study of thermometer calibration corrections have indicated that thermometers which are in constant daily usage (about 10 to 15 cycles per day) for freezing point determinations of styrene have calibration corrections which are constantly changing in a positive direction. This change was found to be continuous and in the order of +0.16 C over a period of seven months. Likewise the changes in correction values were permanent in nature. Thermometers that were only in occasional use changed only slightly.

Acknowledgment:

The authors wish to thank J. E. Symezak and M. J. Decerbo along with their staff in the Styrene Laboratory for obtaining the experimental results. Thanks are also extended to Gilbert R. Atwood, of Koppers Research Department, for performing platinum resistance thermometer freezing point determinations.

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(**1**) American Institute of Physics, "Temperature, Its Measurement and Control in Science and Industry," Reinhold, New York, N. Y., p. 231 (1941).

(**2**) C. A. Bennett and N. L. Franklin, "Statistical Analysis in Chemistry and the Chemical Industry," John Wiley & Sons, Inc., New York, N. Y., p. 255 (1954).

(**3**) R. H. Boundy and R. F. Boyer, "Styrene, Its Polymers, Copolymers and Derivatives," Reinhold, New York, N. Y., pp. 131–134 (1952). (*Am. Chemical Soc. Monograph No. 115.*)

(**4**) R. A. Fisher and F. Yates, "Statistical Tables," 4th Edition, Hafner Publishing Co., Inc., New York, N. Y. (1953).

(**5**) "International Critical Tables," McGraw-Hill Book Co., Inc., New York, N. Y., Vol. I, pp. 102, 104; Vol. II, p. 458 (1926).

(**6**) "Styrene Laboratory Manual," Rubber Reserve Co., Washington, D. C., L.M. 2.2.1.1. (1945).

Discussion of Paper on the Necessity of Fundamental and Widened Research in Strength of Materials[1]

S. L. Hoyt.[2]—The author voices an ardent plea for using the basic properties of metals for design purposes, which he then defines. As long as engineers use generous factors of safety, they can rely on the minimum strength values which are ordinarily determined, along with accumulated experiences. Engineers are also able, up to a point, to make out without precise knowledge of localized stresses. Now that they are required to design for factors of safety that are close to unity, and inasmuch as the reward for saving weight is so great, a new approach to materials engineering is in order. He calls it "Metal Mechanics."

I think it is of some interest that this arises from the use of much higher design values rather than from the numerous failures of steel structures. Actually both fields need that much neglected basic property of (technical) cohesive strength for a proper concept of the response of the structure to the stress system which is imposed upon it.

Many years ago Ludwick analyzed the stress system which is produced by a notch, which we can call localized stress, and pointed out that the relevant properties were cohesive strength and shear strength. By a simplified calculation, I showed[3] that the condition for brittle fracture was determined, not by the conventional "properties" of tensile strength, elongation, etc., but by the ratio of cohesive strength to shear strength, and, further, that the stress is to be resolved into its normal and shear components and the ratio between the two used. It follows that the relation between the stress ratios and the strength ratios determines the behavior with increased load, whether ductile or brittle. I stated further, "If one knew the two controlling properties, cohesive strength and resistance to deformation, and if he thoroughly understood the laws of the notch effect, he would be able to predict by calculation whether a given steel would deform when notched, or open up a crack." [3] The author seems to be in close, though not in complete, agreement with this way of stating the case and he sums it up as "The character of a fracture does not depend on the absolute values of stresses and strengths but on their ratios."

It has always seemed to me that this analysis is the correct starting point for an understanding of brittle fracture in

[1] M. V. Zaustin, "On the Necessity of Fundamental and Widened Research in Strength of Materials," ASTM Bulletin, No. 226, Dec. 1957, p. 52 (TP 240).

[2] Metallurgical Consultant, Columbus, Ohio.

[3] S. L. Hoyt, "Notched Bar Testing and Impact Testing," *Proceedings*, Am Soc. Testing Mats., Vol. 38, Part II, p. 141 (1938).

normally ductile metals. Thus the geometry of the part or of the stress system controls the stress ratio; therefore, a steel part, since it has a fixed strength ratio, will be brittle or ductile in that stress field depending on its particular strength ratio. Furthermore, since the shear strength varies with temperature, that is why we have a transition temperature above which the strength ratio is favorable for ductile behavior. I have gone a little further than the author does by selecting the temperature on the transition temperature curve at which the strength and stress ratios are equal, or at which they match, and have called it the "match point."

It follows from these concepts that (*a*) different notch geometries give different match points for the same steel, and (*b*) different rates of loading affect the behavior and the match point through the effect on shear strength, while (c) it becomes clear why the ductile nonferrous metals fail to reproduce the steel effect. The author mentions the point (*b*) and confirmation was also brought out in a paper by D. S. Clark and collaborators.[4] Then there is the combined effect of temperature and strain rate which I discussed in a paper of the Symposium on Effect of Temperature on the Brittle Behavior of Metals in 1954.[5] There has been a lot of mystery associated with impact or shock loading, but the new concepts simplify the picture by bringing out that its effect, like that of temperature, is the secondary effect of strain rate on the shear strength. I think that these points should ultimately be brought into "metal mechanics."

The author has made an excellent contribution and I am in hearty agreement with him that "the important problems of testing materials are not only to determine cohesive and shearing strengths of various metals but also to investigate their properties individually" and that "metallurgical research should look for metals with high cohesive strengths."

M. V. Zaustin (*author's closure*).—The thought-provoking discussion of Mr. Hoyt reminds us that the need for more realistic understanding and use of mechanical properties of metals is quite old and yet no real progress was made in this direction. I believe that this is due to the fact that shear strength always was, and still is, considered as a function of tensile strength, which can be seen from the fact that in the absence of shear data it is often taken as a fraction of tensile strength. In reality, however, it is shear strength that controls ductility and tensile strength.

One of the principles of scientific investigation is to study each variable separately, whereas our investigation of mechanical properties of metals is mainly based on investigation of tensile strength, which is a combination of two variables. For this reason we do not have a unified theory of strength which would be equally applicable to brittle, hard, and ductile materials. Our metallurgical research is a matter of trial and error rather than a straightforward finding of alloys with desirable properties.

The recent progress of the theory of dislocation, together with some works on shear strength and stresses which appeared in the literature, is very encouraging.

As soon as shear and cohesive strengths of materials will be recognized as basic phenomena which govern strength of materials under all kinds of stresses, the situation will change. We will be able not only to explain many phenomena (as we already can do now), but calculate ductility, brittleness, and strength as affected by speed of stressing, various temperatures, combination of stresses as in the cases of notches and pressurized tanks and other cases of brittle fracture of ductile metals, and finally the phenomenon of fatigue.

[4] J. A. Hendrickson, D. S. Wood and D. S. Clark, "The Initiation of Brittle Fracture in Mild Steel," *Preprint No. 28*, Am. Soc. for Metals (1957).

[5] S. L. Hoyt, "Brittle Fracture," Symposium on Effect of Temperature on the Brittle Behavior of Metals with Particular Reference to Low Temperatures, Am. Soc. Testing Mats., p. 133 (1954). (Issued as separate publication *ASTM STP No. 158*.)

The Elastometer—

A Simple Device for Measurement of Elastic Moduli of Plastics at Elevated Temperatures

By ROBERT A. SPURR, MORRIS J. HELDMAN, AND HOWARD MYERS

In a research effort to synthesize plastic materials satisfactory for use at high temperatures, the need arose for a test method for the rapid determination of the heat resistance of newly synthesized materials and the gathering of data relating properties to composition. Such a method must be suitable for tests at elevated temperatures with controlled atmospheres—oxidizing and nonoxidizing. It must also be capable of examining the small amounts of materials which are typically prepared in synthetic research programs.

A number of tests based upon observation of torsional oscillation or of flexural vibration of sample material have been

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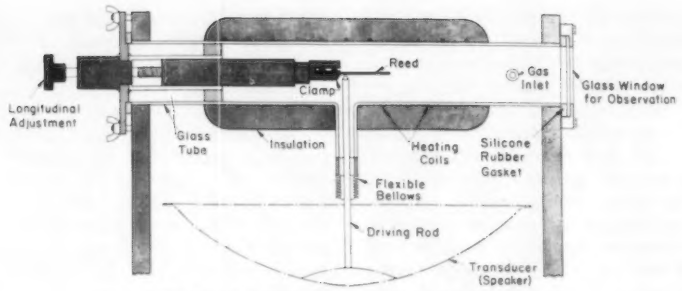

Fig. 1.—Schematic setup of the elastometer.

described in the literature. These tests, which are closely related in principle, have the advantage of avoiding the complicating effects of creep. However, none of the previously described test procedures is completely suitable for testing materials under the severe thermal and oxidative conditions which are of interest in the research program. For this reason an inexpensive testing apparatus, called an elastometer, was devised to meet the requirements. A reed composed of the sample material is held at one end in a clamp and caused to vibrate by a rod pressing on the reed near the clamp. The frequency of vibration at maximum amplitude is observed visually and used in the calculation of the elastic modulus.

The Instrument

Figures 1 and 2 show the device, which is so constructed that specimens can be surrounded with inert or oxidizing atmospheres from room temperature to 1100 F. The specimen clamp is near the center of a heat-resistant glass tube in which the temperature may be suitably controlled. It is possible to maintain a vacuum or an atmosphere of any desired gas by the use of inlet and outlet tubes shown in the photographs. During an experiment, the specimen is observed through the glass window at one end of the glass tube. The specimen is caused to vibrate by means of a rod which extends through a metal bellows attached to a side arm of the elastometer tube. This rod is agitated by a transducer, which is operated by a variable frequency generator and amplifier. The specimen-clamp assembly shown in Fig. 3 can be moved in an axial direction through the tube by turning a knob outside the tube at one end. Thus, the point of contact between the driving rod and the specimen may be changed. Thermocouples are mounted at various points near the specimen on the interior wall of the glass tube. It has also been found possible to place a thermocouple between the clamp and the reed without affecting the vibrational properties of the reed.

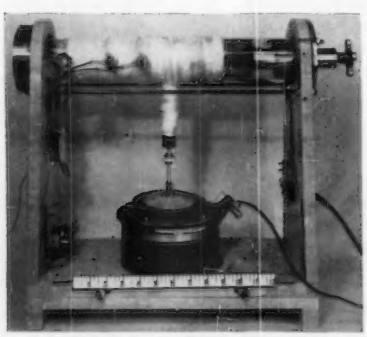

Fig. 2—View of the elastometer showing the inlet and outlet tubes in place controlling the atmospheres.

Test Conditions

Experiments with a variety of plastic reeds were made to determine the test conditions which would give satisfactory results. They may be summarized as follows:

1. The minimum length for the reed is about $1\frac{1}{2}$ in. For this length the point of application of the driving rod should be within $\frac{1}{16}$ in. of the clamp; the perturbing effect of the mass of the rod on the frequency of the reed is then negligible. For a reed length of $2\frac{1}{2}$ in. the location of rod application is less critical.
2. Reed widths between $\frac{1}{16}$ and $\frac{3}{4}$ in. are desirable. Notching and tapering are to be avoided.
3. Thicknesses from $\frac{1}{32}$ to $\frac{3}{16}$ in. have proved satisfactory. (The clamp for the instrument does not permit insertion of reeds greater than $\frac{3}{16}$ in. in thickness.)
4. In the determination of the resonant frequency, the amplitude of the reed vibration should be kept as low as is conveniently observable. There is a slight dependence of apparent resonant frequency upon transducer power.

In an experiment, the amplitude of the free end of the reed is observed through a telescope as the applied frequency is varied. The resonant frequency (frequency of maximum amplitude) is then read from the oscillator dial. The ease with which the determination can be made is surprising. Time required is about ten seconds, and precision of the measurement is approximately 1 per cent. The frequency can be checked and the motion of the reed observed in detail by illumination with stroboscopic light.

Discussion

The dynamic modulus of a material is represented by a complex number, of which the real part measures the elastic properties of the material and the imaginary part is related to the nonelastic or viscoelastic properties. For the materials of interest in the present research program, the imaginary part of the modulus is negligible, and the modulus is given by the equation:

$$E = \frac{38.24\ \rho l^4 f^2}{d^2} \text{ dynes per sq cm}$$

where:

ρ = density of reed, g per cu cm,
l = length of reed, cm,
f = fundamental frequency of reed, cps, and
d = thickness of reed, cm.

The derivation of the formula for the elastic modulus from the differential equation describing the motion of a vibrating reed is given by Morse.[1] One of the interesting results of this treatment is that for a rectangular reed the frequency of the first overtone is approximately six times that of the fundamental. There is no difficulty in distinguishing the intense fundamental from the weak reed overtones and the equally weak frequencies of interaction between reed and apparatus. In this treatment the generally small viscosity effects are ignored; these effects are considered by Horio and Onogi.[2] Strella[3] treats a viscoelastic reed weighted on the free end. (It should be noted that

[1] P. M. Morse, "Vibration and Sound," Second Edition, McGraw-Hill Book Co., New York, N. Y., pp. 157–164 (1948).
[2] M. Horio and S. Onogi, "Forced Vibrations of a Reed as a Method of Determining Viscoelasticity," *Journal of Applied Physics*, Vol. 22, p. 977.
[3] S. Strella, "Vibrating Reed Test for Plastics," ASTM BULLETIN, No. 214, May, 1956, p. 47 (TP105).

Fig. 3.—Specimen-clamp assembly.

Eqs. 1, 2, and 3 of the Strella paper, which give his results, contain errors. These may be corrected by reference to the Appendix of his paper.)

The elastic moduli of a number of specimens have been measured both with the elastometer and with a Baldwin-Lima-Hamilton universal testing machine. Since the latter machine measures the specimen in flexure at a relatively slow rate of loading, the indicated strain includes a contribution due to elastic deformation plus another contribution due to creep, so that the ratio of stress to strain should be somewhat less than the corresponding ratio indicated by the elastometer; in Table I the comparative data bear out this expectation with two exceptions.

Another set of measurements was made at elevated temperatures. Strips were cut from a 6-ply phenolic, glass-fabric laminate which had received a moderate cure. These were inserted into the elastometer tube, which had been heated to a predetermined temperature, and the modulus was measured as a function of time. The resulting data are given in Fig. 4, which shows that at 400 F the modulus remains constant; at 500 F and at 600 F there is some decrease with time; and at 700 F the decrease is comparatively rapid. The initial drop of modulus with time is due to the increase of temperature of the specimen following insertion into the heated chamber. The increase of modulus which follows the initial drop is the result of a curing effect. It may be seen that the temperature of rapid modulus decrease may be used as a criterion of temperature stability.

TABLE I.—PRELIMINARY DETERMINATIONS OF ELASTIC MODULI OF PLASTICS AT ROOM TEMPERATURE ON TWO DIFFERENT TEST MACHINES

Specimen Identification and Description	Average Modulus, dynes per sq cm	
	Baldwin	Elastometer
Unfilled acrylic plastic	3.6×10^{10}	4.0×10^{10}
Unfilled acrylic plastic	3.7×10^{10}	4.8×10^{10}
Paper-base phenolic	5.1×10^{10}	7.3×10^{10}
Paper-base phenolic	1.1×10^{11}	9.7×10^{10}
Dialyl phthalate polyester glass-cloth laminate		
Crosswise	1.3×10^{11}	3.3×10^{11}
Lengthwise	.....	2.9×10^{11}
Diallyl Phthalate polyester unidirectional glass-cloth laminate, lengthwise	1.2×10^{11}	3.2×10^{11}
Polyester unidirectional glass-cloth laminate		
Lengthwise	1.6×10^{11}	2.5×10^{11}
Crosswise	.....	1.2×10^{11}
Phenolic glass-cloth laminate; postcure 18 hr at 275 F	2.6×10^{11}	2.3×10^{11}
Phenolic glass-cloth laminate	1.4×10^{11}	2.6×10^{11}

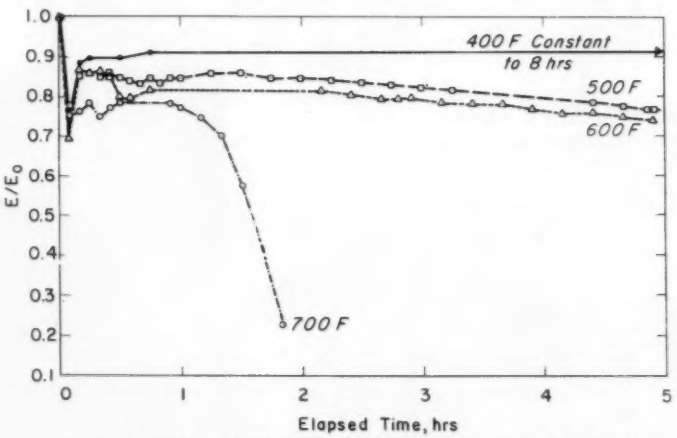

Fig. 4.—Relative moduli of phenolic glass-cloth laminate at various temperatures as a function of time.

Further studies are yielding information on the relative moduli of various plastic materials at elevated temperatures, and on the role of oxidation in the thermal degradation process. It is clear that considerable useful information can be obtained by the use of this simple device.

Automatic System for Spectrometric Data

AUTOMATIC data processing equipment now in use at the National Bureau of Standards is providing almost immediate information on the homogeneity of metals and alloys. By means of a specially designed electronic read-out, analyses obtained on a direct-reading spectrometer are automatically recorded on punched cards in a form which permits high-speed statistical analysis on an electronic computer. As a result, information is obtained in minutes which in the past would have required weeks of work by several operators.

The automatic data handling system is being employed in an expanded program for the preparation of spectrometric standard samples, which the Bureau distributes for calibration of spectrometers in other laboratories. At present the Bureau issues over 550 different standard samples of chemicals, metal, ores, and ceramics—all certified materials which have been carefully analyzed or whose physical properties have been precisely determined. However, recent requests from industry have indicated a need for a greatly increased number of spectrometric standard samples. Uniformity of composition is especially important in such materials, so that a rapid means for assessing hemogeneity of specimens was needed.

The spectrometer and electronic read-out were designed and built by Baird-Atomic, Inc., in accordance with the Bureau's requirements. The spectrometer provides for analysis in terms of 36 chemical elements, any 18 of which may be observed simultaneously. As in other spectrometers of this type, an electric spark vaporizes a minute portion of the sample, and the light from the spark passes through a slit to a diffraction grating, which disperses the light to form a spectrum. A selected spectral wavelength for each chemical element passes through a slit to a phototube, and the electric current produced by the tube is stored as a charge on a condenser. At the end of the exposure the amount of each element present is measured by the charge on the corresponding condenser.

In the present instrument, the heart of the recording system is a storage unit in which measured charges on condensers are indicated as numbers on glow tube registers. The end of each glow tube bears a circular scale of digits from 0 to 9 and the measured digit is indicated by the position of a glowing spot in the tube. Four registers, together representing a 4-digit number, constitute a single channel of

(*Continued on page 91*)

The Low-Temperature Brittleness Testing of Polyethylene

By P. N. BESTELINK and S. TURNER

A new apparatus and subsidiary equipment

IT IS CUSTOMARY to obtain a measure of the low-temperature serviceability of polymers from a low-temperature brittleness test. A simple aim of such tests would be to determine the temperature above which no, and below which all, specimens tested will break when stressed under fixed but arbitrarily chosen conditions. However, many polymers—polyethylene is a well-known example—exhibit not a sharp brittleness temperature, but a temperature range over which the fractures are distributed subject to some probability relationship. The gradual development of a test widely used in this field (ASTM Method D 746)[1] bears witness to some of the difficulties which arise from this behavior. In the laboratories of Imperial Chemical Industries Limited (ICI), an alternative apparatus to that described in the ASTM test was developed many years ago[2] and fairly recently has been redesigned and improved. In its improved form it has been used in a fairly extensive survey of the low-temperature brittleness of polyethylene, some aspects of which have been reported previously (1).[3] In our view, the ICI apparatus has the following advantages over the ASTM machine:

1. The specimens are not immersed in a liquid and, therefore, there is no potentially harmful environment.

2. Temperature control is simple and definite. Temperature control to ±0.25 C can be attained, and the apparatus can be used to study changes in the specimens which occur with some polymers exposed to low temperatures, for example, changes in crystallinity leading to embrittlement.

3. Large numbers of specimens can be accommodated; this is useful when polymers such as polyethylene are being studied.

4. Because of the smaller specimen size the apparatus can give reliable results on small samples, which is particularly useful when laboratory batches

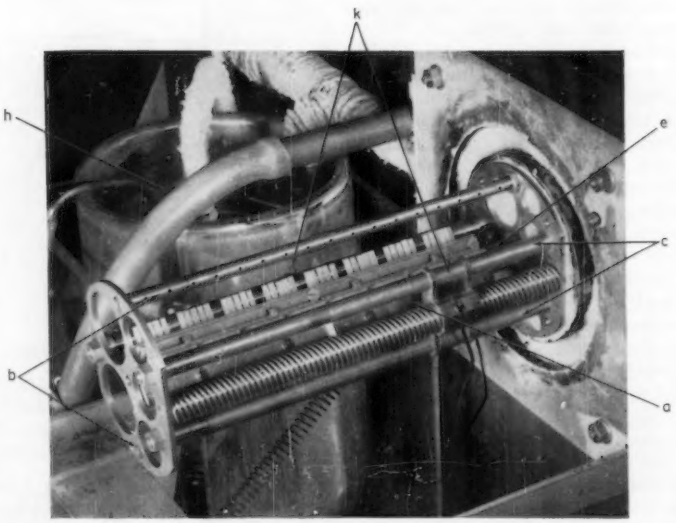

Fig. 1.—Low-temperature brittleness apparatus. The testing assembly.

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S. TURNER has been engaged for the past five years on research into the mechanical properties of viscoelastic materials, polyethylene in particular. During part of this time he has been concerned with problems associated with the standardization of testing methods.

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] 1955 Book of ASTM Standards, Part 6, p. 148.

[2] The original test method was developed by W. G. Oakes in the laboratories of the Alkali Division, Imperial Chemical Industries Ltd.

[3] The boldface numbers in parentheses refer to the list of references appended to this paper.

of experimental polymers are being evaluated.

The apparatus is of relatively simple construction, robust and easily operated. Its advantages are such that it may well prove useful in characterizing a wide range of polymers as well as polyethylene. It has already been shown (1) however, that the specimen preparation procedure must be considered an essential part of any low-temperature brittleness test for polyethylene, and this may apply to other polymers too. We have therefore developed an apparatus to prepare and notch specimens for use in the test; this machine prepares accurately reproducible specimens at a rate of one per second. Both the test apparatus and the specimen notcher and cutter are described in detail below.[4]

Low-Temperature Brittleness Machine—General Description

The principle of the testing method incorporated in the apparatus is the same as that used in ASTM Method D 746, the main differences being the slower testing speed, some differences in the deformation imposed on the specimens, the comparatively small dimensions of the specimens, and the elimination of a liquid cooling medium.

The basic test condition is that specimens 2 cm long, 0.25 cm wide and 0.16 cm thick are clamped at one end to a spindle which can be rotated at a constant angular speed past an anvil. The specimen can be notched if desired, in which case the notch should lie just outside the clamp and in one side of the specimen. As they pass the anvil the specimens are bent through almost 90 deg of arc in $\frac{7}{24}$ sec, around a mandrel of 0.4 cm radius attached to the spindle; the gap between mandrel and anvil is 0.2 cm when at its narrowest, inducing a maximum skin strain of about 0.09 in the specimens, unless they break beforehand. A full charge of the apparatus comprises 160 specimens, arranged in four banks 90 deg apart around the spindle circumference; the 40 specimens in each bank are spaced off in 8 groups of 5, as will be clear from Fig. 1, the width of the anvil being a little in excess of the width of one such group. Thus, when the semiautomatic drive is operated to produce one spindle revolution, 20 specimens at a time are tested; the anvil is then moved to a position adjacent to the next group of specimens and these can be tested at either the same, or a different temperature.

[4] The machines described in this paper are prototypes, but full engineering drawings have been prepared and several brittleness testers have been made commercially. The intention is that each machine will have a specimen notcher and cutter as standard ancillary equipment.

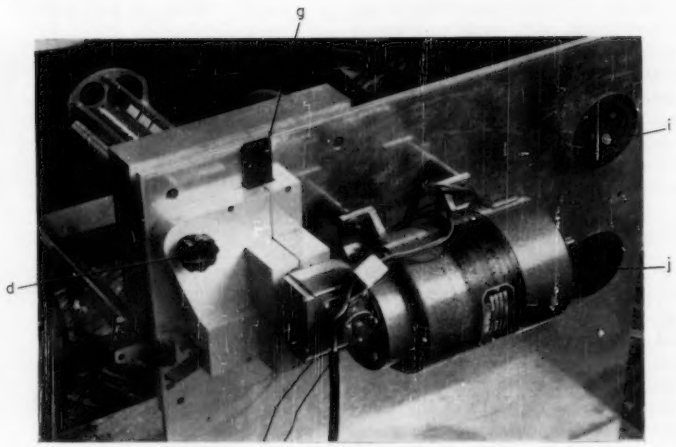

Fig. 2.—Low-temperature brittleness apparatus. The front panel.

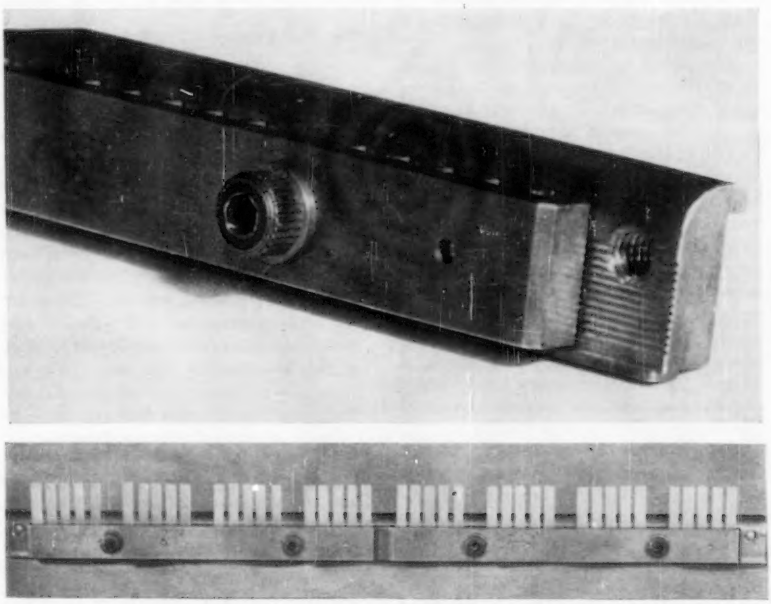

Fig. 3.—Specimen clamps showing composite mandrel clamp unit. Serrations give good grip.

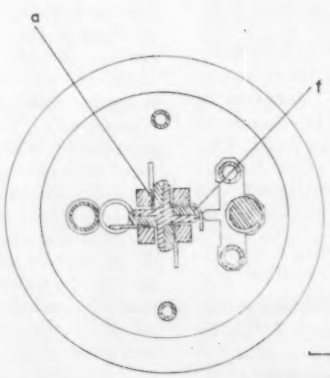

Fig. 4.—Specimen holder and anvil assembly. End view.

Figures 1 to 4 illustrate various aspects and details of the apparatus which comprises four main parts; a mounting base, made of aluminum alloy; a testing assembly, enclosed in an unsilvered Dewar vessel during operation; a drive and semiautomatic clutch; a temperature control system employing dry air as the heat-exchange medium.

Testing Assembly

The main requirements of this part of the machine are that the anvil, although movable along accurately positioned guide rods, shall be rigidly held during the test; that the test results at any particular temperature shall be observable through the walls of the thermostat; that the mounting of the specimens shall be secure and yet simple; and that the weight of metal employed shall be reduced to a minimum in order to reduce the times involved in achieving a particular temperature.

The assembly is mounted (see Fig. 1) in cantilever fashion on a vertical head plate made of asbestos cement in which a circular groove accommodates the mouth of the Dewar vessel to constitute the thermostatted chamber. This Dewar vessel is unsilvered and hence the number of broken specimens and the position of the anvil, *a*, can be seen at any time. Two perforated tubes, *b*, admit a controlled mixture of warm and cold air. The anvil rides on two hollow guide rods, *c*, and on a spindle with four-start thread, operated by a knob, *d* (Fig. 2); a ball catch in this knob locates the anvil opposite any selected group of specimens. The central spindle, *e* (Fig. 1) has a cross-shaped section, shown diagrammatically in Fig. 4, and carries four easily detachable specimen holders. As has already been stated, each holder can accommodate 40 specimens which are arranged in eight groups of five specimens, each group being separated by about 0.6 cm from its neighbor. Each specimen is held in a slot in the clamp bar and the clamp face which contacts the back of the specimen (that is, the face of the specimen which is in compression during the test) is serrated to insure good gripping of the specimen even when there is some variation in specimen thicknesses. The details of the specimen holders can be seen in Fig. 3. The detachable specimen holders incorporate the mandrels around which the specimens are bent as can be seen in Fig. 3 and in Fig. 4 (*f*).

Drive

The central spindle, to which the specimen holders are clamped has to rotate at a uniform speed, despite resistance from the specimens being bent, and has to cease rotating after one revolution. An electric motor of adequate power geared down to rotate at 70 rpm is connected to the spindle, while running at full speed, by the manual engagement of a clutch system. After one revolution the clutch is automatically disengaged by a cam system on the spindle while the motor shaft continues to rotate. The exact starting position of the spindle and clutch is restored by operation of a slider, *g* (Fig. 2).

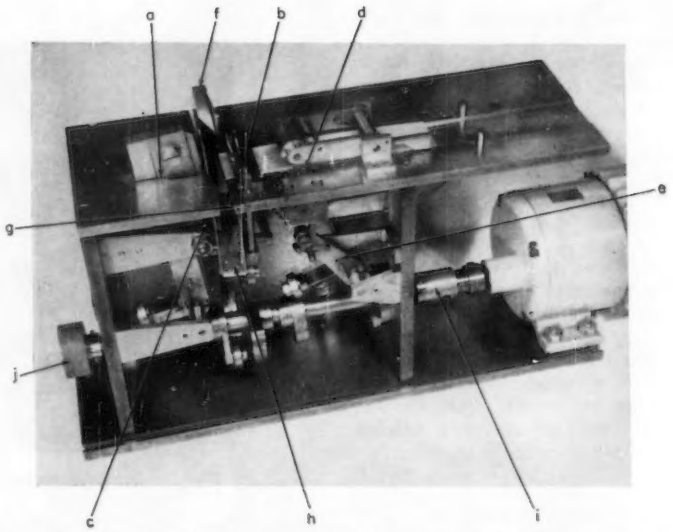

Fig. 5.—Automatic brittleness specimen notcher and cutter (ABSNAC). The working parts are normally enclosed by transparent covers.

Temperature Control System

Dry air, from a constant pressure supply, is used as a heat exchange medium and is passed through a 26 threads per inch needle valve via a water trap into a cooling coil, *h* (Fig. 1) immersed in a methanol solid carbon dioxide bath. The water trap prevents any moisture from passing into the cooling coil where it could rapidly cause a blockage. The cold air then meets dry room-temperature or heated air admitted through a 40 threads per inch needle valve and the two streams mix inside the head plate of the testing assembly and pass on into the Dewar enclosure (not shown). This Dewar vessel is surrounded by a transparent plastic box which slides along the rails seen in Figs. 1 and 2. The box is held in position by two helical springs which pull the mouth of the Dewar vessel into the packing in the groove cut into the head plate. To increase the thermal insulation, the head plate is mounted clear of the front panel, on which the operating knobs of the needle valve are visible, *i* and *j* (Fig. 2). For setting the enclosure temperature it is adequate to use the indicated needle valve positions with the help of a calibration chart, provided the cold bath is always kept well charged. By setting the air valves appropriately the machine can be left to achieve thermal equilibrium very near to any desired temperature with no attention apart from replenishing the cooling bath with solid carbon dioxide occasionally. Because of the particular method adopted for computing the brittleness temperature, T_{50}, there is no need to work at any precisely defined test temperature, but temperature equilibrium is required, and the temperature must be measured fairly accurately. This is done using two thermocouples, *k* (Fig. 1), one of which is mounted halfway down the thermostat, the other one on the anvil. The potentiometer for reading the thermoelectric voltage is external to the apparatus. The exhaust air passes through a heat exchanger (not shown), and is used to precool the incoming air.

Temperature control has been found to be good; the cold space can be brought down to −70 C in about 35 min, temperature gradients do not exceed 0.5 C across and 1 C along the Dewar enclosure. A complete experimental run, that is 160 specimens through eight different temperatures, never takes longer than 3 hr.

Automatic Brittleness Specimen Notcher and Cutter (ABSNAC)

The results reported earlier (1) suggest that interlaboratory agreement on brittleness temperatures will be virtually impossible, unless the specimen preparation is carried out in a standard manner. Even in one laboratory hte progressive decrease in the sharpness

of the cutting tool will have an effect so that strict comparison of results over a period of time will not be valid. A solution of this difficulty might lie in carrying out the test on notched specimens, and it has been shown already that the notch should be in the side rather than on the face of the specimen. If this is to be done some device must be used to enable the notching to be carried out rapidly and reproducibly.

A machine for preparing specimens, that is, notching and cutting, should satisfy the following demands:

1. It should be manipulated easily by a semiskilled operator.
2. It should cut and not shear the material.
3. It should produce straight clean faces and parallel-sided specimens of uniform width.
4. The notch depth should be uniform, constant from specimen to specimen, and adjustable.

These basic requirements have been met in our machine (called ABSNAC for convenience), into which are fed strips of polymer 2 cm wide and of any suitable lengths cut from sheet 0.16 cm thick (sheet $\frac{1}{16}$ in. thick is satisfactory.) From these strips are produced specimens 2.0 ± 0.03 cm long, 0.25 ± 0.005 cm wide, and 0.16 ± 0.01 cm thick with a notch in the side (if required). The notch depth can be adjusted to fine limits; a practically useful depth is 0.040 ± 0.002 cm. The most satisfactory position for the notch is midway along one side of the specimen, that is, just outside the clamp.

Figure 5 is a photograph of the apparatus which can be seen to consist of a mild steel box-frame on which all components are mounted. It contains a motor-driven shaft with four cams, a notching mechanism, a feeding mechanism, and a parting-off mechanism.

The preparation of a specimen follows the sequence shown diagrammatically in Fig. 6. The detailed operations are:

1. The lever bearing the notching blade, *a* (Fig. 5) approaches the end of the strip of material which is held firmly in a groove in the top plate by a clamp, *b;* the blade, which is a standard double edged razor blade 0.005 in. thick, penetrates the material to the required depth and is returned to its initial position. The notch depth can be varied from zero to 0.10 cm by an adjustable eccentric cam, *c*.

2. The clamp, *b*, lifts and a feed roller, driven by a ratchet wheel, *d*, advances the strip of material 0.25 cm, after which the clamp closes again. The ratchet wheel is operated by one arm of an angle lever, *e*.

3. The cutting blade, on a lever, *f*, moves forward along a hardened steel

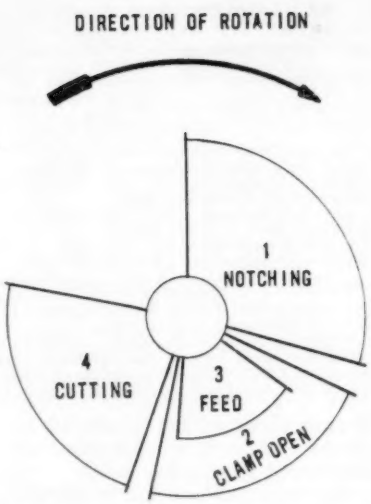

Fig. 6.—Sequence of action by the cams.

lip, *g*, and cuts off the specimen, which leaves the apparatus via a chute, *h*.

The apparatus is driven at 60 rpm by a $\frac{1}{50}$ hp induction motor which can be uncoupled by moving a splined bush, *i*, thereby enabling the shaft to be rotated by a knob, *j*, when initial adjustments are being made.

Experimental Results on Notched Specimens

Considerable experimental work has been carried out using this machine, mainly to determine the constancy of the notch and the influence of notch depth upon the brittleness temperature. Most of the work has been on the Alkathene brand of polyethylene, of density about 0.92 g per cu cm and with melt flow indices varying from 2 to 70, but machine works quite efficiently on high density polyethylenes. The total variation of the notch depth for any particular depth setting is never more than 0.003 cm for a notch 0.05 cm deep and for the shallower notches is considerably less. So far we have not determined the frequency with which the razor blades should be replaced but during our preliminary assessment of the apparatus they have been replaced after cutting about 500 specimens. This is probably much more frequently than is necessary, although the frequency will depend on the hardness of the polymer.

In tests on notched specimens the crack always propagates part of the way across. Only when the specimen is completely broken into two pieces is a failure recorded.

Table I below shows the brittleness temperature on three Alkathenes of different melt flow index, notched to different depths and conditioned prior to testing by immersion in boiling water for 10 min. Two years ago the same samples of polymer provided specimens which were notched by a crude hand tool and for which results were published earlier (1). For convenience the relevant earlier results are quoted in Table I.

It can be seen that for Alkathene 20 T_{50} changes only slightly for notch depths between 0.012 cm and 0.050 cm. For very shallow notches the changes in T_{50} are quite marked, and this is in full agreement with the fact that specimen preparation affects T_{50} in the standard test. For Alkathene 2, which is a tougher polymer, there was considerable scatter of results for the smaller notch depths and it seems, therefore, that a standard notch depth of 0.040 cm should be adopted.

The agreement between the present results for specimens prepared automatically and results obtained two years ago on specimens prepared by hand from the same polymer samples is very encouraging.

Evaluation of Results

In two-temperature brittleness testing, as normally carried out with unnotched specimens, the greatest difficulty is that of deciding on a test procedure which gives reliable results. For the test to be equally applicable to both routine and investigational work, one needs a test which gives results at reasonable speed while at the same time reducing to a minimum the influence of

TABLE I.—BRITTLENESS TEMPERATURE, T_{50}, AND STANDARD DEVIATION, σ, DEG CENT.

Notch Depth and Notching Mechanism	Alkathene 20[a]		Alkathene 7		Alkathene 2	
	T_{50}	σ[b]	T_{50}	σ[b]	T_{50}	σ[b]
No notch	−49.5	5.0	..	..	..	..
No apparent notch[c]	−23.0	3.5	..	..	..	..
0.012 cm automatic	−13.5	0.5	−24	1.0	ca. −57	ca. 5
0.030 cm automatic	−12.5	1.5	−20.5	1.0	ca. −46	ca. 8
0.040 cm automatic	..	..	..	..	−47.5	1.5
0.050 cm automatic	−12.0	0.5	..	..	..	..
0.030 cm hand notcher	−12.5	1.0	−21.5	1.0	−44.0	2.0

[a] The number after Alkathene denotes melt flow index.
[b] Values of standard deviation are approximate only.
[c] In this case the notching blade was just touching the specimen at its limit of travel, but the specimens appeared to be unnotched when examined in good light by the unaided eye.

subjective factors. The simplest solution of this problem appeared to be to invest a large number of specimens in each test; this does not make undue demands on material supplies, since the specimens are small.

The low-temperature brittleness fracture is a statistical event and, owing to its nature, subject to a binomial frequency distribution. It is customary to assume that temperature is a suitable measure of severity in the test; after trying some alternative measures, for example reciprocal absolute temperature, we saw no good reason for abandoning this usage. Further investigations showed that the probability of fracture, at least of polyethylene specimens, is normally distributed with temperature as the severity, so that a plot of test results on arithmetical probability paper gives a good straight line, provided that a sufficiently large number of specimens is tested. The need for large numbers of specimens arises from the nature of the binomial frequency distribution of observable fractures at a given probability of fracture (or severity); some further relevant information has been collected in the appendix. Thus in all cases where the distribution of fractures over severity is broad (polyethylene is an example), the accuracy and reliability of a result depends on the use of a number of specimens.

Using the apparatus described, it is possible to meet this requirement without undue expenditure of time and effort. A standard procedure has been adopted in which 20 specimens, unnotched but conditioned by immersion in boiling water for 10 min. are tested at each of eight temperatures and the percentage fracture plotted on arithmetic probability paper; from the plot, T_{50}, the temperature for 50 per cent fracture, and σ, the standard deviation of the distribution, can be read if the best straight line is fitted to the data. In drawing this line, of course, only displacements along the abscissa must be considered. This procedure is permitted in ASTM Method D 746. The fitting of the best straight line can be done by eye with adequate accuracy in most cases. During the work on polyethylene (1) this question was investigated in some detail and Table II gives some of the results obtained. It seems that it is quite adequate to draw a straight line by eye through the points plotted on probability paper ("provisional line") if most weight is attached to results between 20 and 80 per cent fracture. In only one of the five cases considered, which were selected because the experimental points were rather scattered, is the T_{50} point altered much by computing the first regression line by the method of weighted probits (2).

TABLE II.—BRITTLENESS TEMPERATURES, T_{50}, AND STANDARD DEVIATIONS, σ, OF SOME POLYETHYLENE SAMPLES.

The numbers accompanying the brand name in the first column indicate the melt flow index (ASTM D 1238 – 52 T);* the method of specimen preparation is also given.

Material	Provisional Line		First Regression Line			
	T_{50}	σ	T_{50}	σ	S^a	χ^2
Alkathene 20 guillotine cut	−34.5 C	5.5 C	−34.5 C	6.6 C	±0.7 C	7.2
Alkathene 20 razor cut	−69.5 C	12.5 C	−69.3 C	13.5 C	±0.9 C	0.8
Alkathene 20 + 2.5 per cent Kosmink[b] knife cut	−33 C	7 C	−31.4 C[c]	5.8 C	±0.5 C	25.4
Alkathene 20 + 2.5 per cent Kosmink razor cut	−46 C	13 C	−45.7 C	10.5 C	±0.9 C	5.76
Alkathene 7 knife cut	−50.5 C	5.5 C	−50.2 C	8 C	±0.9 C	5.9

* Tentative Method of Test for Measuring Flow Rates of Thermoplastics by Extrusion Plastometer, 1955 Book of ASTM Standards, Part 6, p. 292.

[a] S = Standard error of the T_{50}.

[b] Channel black manufactured by United Carbon Co.

[c] In this particular case T_{50} is probably accurate within the limits of the modified standard error of ±0.8 C (obtained by multiplying S by the heterogeneity factor $\{\chi^2/(k-2)\}^{1/2}$ where k is the number of test temperature employed.

It seems, therefore, that the drawing of a provisional line by eye is adequate except in very special cases.

The procedure retains a certain amount of flexibility; in the case of an entirely unknown material the choice of subsequent temperature during a test may be guided to some extent by results already obtained, with the object of obtaining most answers between 10 and 90 per cent fracture and symmetrically disposed around T_{50}; on the other hand, if the test result is approximately known, the number of temperatures used may be lessened and specimens saved, or the accuracy increased by testing several times twenty specimens at only two temperatures, for example, the expected 25 and 75 per cent fracture temperature. Such a two-point test does in fact give the highest accuracy for a given number of specimens. Other possible test procedures were thus rejected, for example, Kärber's method (as outlined in Method D 746) because of its uncertain search for the 100 per cent fracture point, and the sequential (up-and-down) method (3) in which, after each result on a single specimen, the temperature has to be changed accurately by a fixed interval: this is expensive in time or equipment.

If a test involving notched specimens is used the problem of computing a "brittleness" temperature is much simpler, for polyethylene at any rate. This is because the standard deviation of the distribution is much smaller than for unnotched specimens, being 1 or 2 deg Cent. A linear interpolation between results obtained on a small number of specimens tested at two temperatures, one lying on each side of T_{50}, will usually be adequate. Tests on notched specimens have shown that good reproducibility and freedom from any influence due to the mechanical aspects of specimen preparation can be attained. In addition, the distinction which the present test shows between polyethylenes of different melt index is still preserved when the specimens are notched.

Conclusions

The low-temperature brittleness test for polyethylene demands the use of large numbers of specimens if reliable results are required, and hence some machine such as the one described, capable of accommodating large numbers of specimens, is desirable. No correlation between results from different laboratories will be possible, however, until specimen preparation is standardized, and a simple way to effect this is to use notched specimens. The machine described will cut and notch specimens in a reproducible manner at a rate of 1 per sec, and the use of such specimens will give a narrow distribution of fractures, which will reduce the number of specimens required for a brittleness determination. The use of notched specimens will not eliminate completely the effects of thermal history upon T_{50}, and a standard conditioning treatment will be necessary still. Our experience suggests that a simple conditioning treatment, such as the one used in this work, is all that is necessary.

Acknowledgments:

The authors would like to acknowledge the collaboration of their colleagues and in particular the assistance of Mrs. H. E. Barr, R. J. T. Clabburn, and L. J. Tostevin.

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APPENDIX

The Experimental Scatter of Results—Unnotched Specimens

The "brittleness" temperature, T_{50}, is defined as the temperature at which 50 per cent of a very large number of specimens can be expected to break. However, when specimen batches of finite sizes are being tested, even in the absence of perturbing effects such as poor temperature control or faulty specimen preparation, there will be some scatter of individual results at different severity levels, due to the binomial frequency distribution. This distribution is given by

$$f(r;\ n,\ p) = \frac{n!}{r!(n-r)!}p^r(1-p)^{n-r} \quad . . (1)$$

where:

p = the probability of fracture, which appears to be mainly determined by temperature in this type of test,
n = the number tested,
r = the actual number fractured, and
f = the frequency of occurrence of r fractures.

Values of $f(r;\ n,\ p)$ taken from published tables (4) were summed up to give

$$F(r;\ n,\ p) = \sum_{r=0}^{r=x} \frac{n!}{r!(n-r)!}p^r(1-p)^{n-r} \quad . . (2)$$

$F(r;\ n,\ p)$ is the cumulative frequency for different expected probabilities of fracture, p; the cumulative frequency is plotted as abscissa and the upper limit of the summation, expressed now as a percentage fracture, is the ordinate in Fig. 7, which is calculated for $n = 20$. The abscissa is plotted on a probit scale on which the cumulative curve of a Gaussian distribution would be represented as a straight line. It can be seen that for $p = 0.5$, the cumulative binomial distribution is almost Gaussian, between $F(r;\ n,\ p) = 5$ and 95 per cent, but that as p varies from the middle value the distribution becomes more and more skew; this skewness can be seen more readily by plotting $f(r;\ n,\ p)$ *versus* r, with p as parameter again. For $n = 10$ and $p = 0.5$, the approximation to a straight line is good only between $F(r;\ n,\ p) = 20$ and 80 per cent, but for n increasing the approximation of the binomial distribution to the Gaussian distribution becomes closer.

Vertical dotted lines in Fig. 7 show the 25 and 75 per cent limits of the cumulative curves; the actual experimental result will thus have a 50-50 chance of lying outside the limits set by the ordinates of the intersections of the cumulative curves with these vertical lines. In Fig. 8 a hypothetical Gaussian distribution of fracture over severity has been assumed and from the data of Fig. 7, and similar tabulated data, limiting curves have been drawn between which 50 and 80 per cent of all results should lie, for $n = 20$. Fifty per cent limits for $n = 80$ and $n = 10$ are also drawn in the upper part of Fig. 8. The curves can be seen to diverge from the ideal line at high and at low percentages, indicating lower reliability of results in these regions; this, incidentally, is one of the reasons for selecting the 50 per cent fracture point rather than the 5 or 10 per cent fracture point as a characterizing feature for brittleness.

The inescapable fact that there will be relatively large experimental scatter in materials not exhibiting an abrupt change from nonbrittle to brittle behavior implies that large numbers of specimens must be used in order to evaluate the low-temperature brittle point with reasonable accuracy, and the investigations already carried out in the low-temperature brittleness behavior of polyethylene illustrated very well the advantages of having a machine capable of testing large batches of specimens so that statistically significant results can be obtained. The determination of the actual distribution of fractures over severity is a problem which requires extensive experiments involving large numbers of specimens; similarly, extensive experiments might yield a definite answer to the question of what mechanism governs the fracture of polyethylene specimens in a brittleness test.

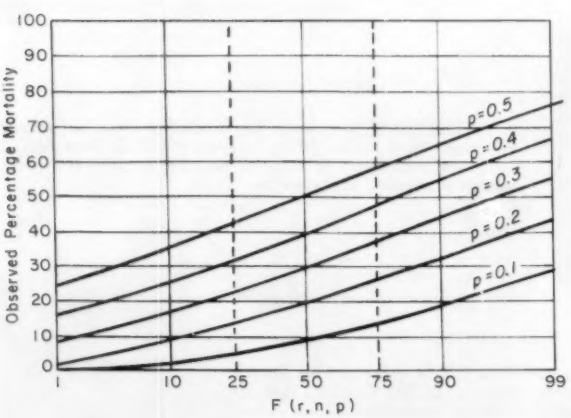

Fig. 7.—Cumulative frequency curves showing the chance of a particular observed mortality not being exceeded.
Expected probability is the parameter.

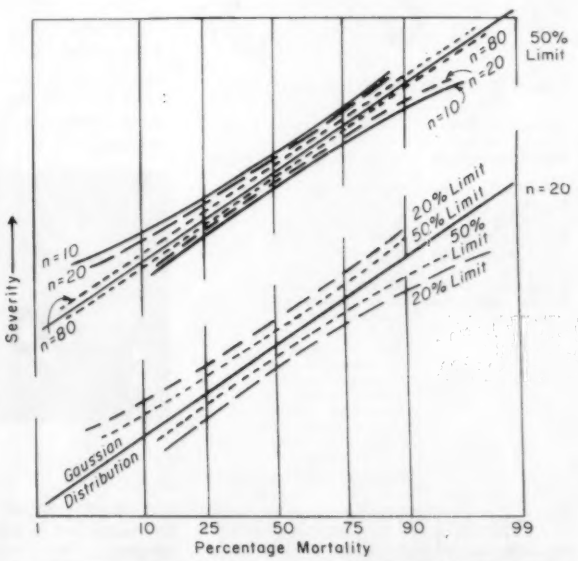

Fig. 8. Limits outside which experimental points will fall in a given proportion of cases.
In the upper part of the figure 50 per cent limits are shown for different values of n; in the lower part different limits are shown for $n = 20$. A Gaussian distribution of fracture over severity has been assumed (solid straight line). See appendix for full details.

Tests for and Engineering Properties of Ceramic Tile*

By J. V. FITZGERALD and E. L. KASTENBEIN

A collection of common and special purpose tests which have been successfully applied to ceramic tile

AN IMPORTANT activity of the Research Center of the Tile Council of America, Inc., is the testing of the industry's product. The goal of this program—better standardization of tests and thereby of product—is vigorously pursued. The Research Staff of the Council not only tests tile by means of long-established procedures but also actively develops tests for the many new applications which continually present themselves.

A list of tests for ceramic tile is given in Table I. This list is divided into two categories: (1) common tests which are often used and many of which are generally accepted as standard, and (2) tests which are used for special purposes.

The Tile Council has investigated many of these tests and in some instances has helped to promote their acceptance as standard by the industry.

Detailed methods for running most of the tests are contained in Federal Specification SS-T-308; ASTM Standards; and Reports of the Tile Council of America.

TABLE I.—TESTS FOR CERAMIC TILE.

Common Tests	Special Purpose Tests
Water absorption	Rate of water absorption
Abrasive hardness	Weathering
Resistance to crazing	Wear service
Bond strength	Knoop hardness
Color matching	Scratch resistance
Wedging	Slipperiness
Warpage	Thermal shock
Bulk specific gravity	Moisture expansion
	Thermal expansion
	Radioactivity
	Modulus of rupture
	Tensile strength
	Compressive strength
	Impact strength
	Young's modulus
	Electrical conductivity
	Thermal conductivity
	Chemical resistance
	Efflorescence
	Specular gloss

NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the authors. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

* Presented at the ASTM Second Pacific Area National Meeting in Los Angeles, Calif., Sept. 16–22, 1956.

[1] 1955 Book of ASTM Standards, Part 3, p. 821.

Specific Tests Described

Water Absorption

Even the experienced engineer has a problem in producing day after day, ceramic pieces of the same uniformity in structure, strength, water resistance, and strain resistance. Fortunately, water absorption measurements give him an indication of these properties and are used throughout the industry to determine firing conditions.

Depending on the per cent of water absorbed, the ASTM Definitions of Terms Relating to Ceramic Whitewares (C 242 – 55)[1] classify ceramic tile according to four different degrees of vitrification, as follows:

Degree of Vitrification	Water Absorption, per cent
Impervious	Less than 0.5
Vitreous	Less than 3
Semivitreous	3 to 7
Nonvitreous	Over 7

The absorption tests consists essentially of drying specimens to constant weight, boiling them in distilled water for 2 hr, allowing to cool, wiping the excess water off the surfaces, and reweighing.

Comparing weight (per cent) of water absorptions of a number of different types of ceramic materials can lead to erroneous conclusions since large differences in densities of the materials may cause the percentages of water absorbed by volume to be different while the weight percentages are still almost identical. However, when working with one particular type of material (generally ceramic tile fall into one type), weight percentages are satisfactory for comparison.

Water absorptions for glazed wall tile manufactured in 1931, 1953, and 1957, are shown in Fig. 1. In the past 25 years the range of water absorptions has narrowed considerably. Nevertheless, some foreign tile absorb as much as 25 per cent water and are characterized by weakness and a tendency to crack spontaneously when set in mortar or to fracture on impact when installed by organic adhesives.

Rate of Water Absorption

Nonvitreous tile must be soaked prior to setting in conventional portland-cement mortars to prevent the otherwise dry tile from absorbing water

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which is needed for curing. Consequently, the rate of water absorption must be known in order to fix the minimum duration of the soaking prior to setting.

In the test the dried tile are weighed immersed in water, removed at various intervals, surface water is removed and the tile reweighed. The per cent absorption by weight is determined from the dry and wet weights.

A typical curve for rate of water absorption for glazed ceramic wall tile is shown in Fig. 2. In 2 min the tile had absorbed about 70 per cent of its total.

Weathering Test

The freezing-and-thawing test consists of boiling tile specimens in distilled water for 2 hr, allowing the specimens to cool to room temperature while still totally immersed, removing the excess water from their surfaces, and placing them in a freezing chamber maintained between 6 and 14 F. After 4 hr, the specimens are removed from the freezing chamber and immediately immersed in room-temperature water. It has been found essential to maintain the temperature at 14 F. The rate at which freezing occurs appears to be very important and depends not only on the temperature of the freezing chamber but on its geometry and cooling capacity. Likewise, the degree of saturation of the capillary structure by water is a factor.

After the tile have thawed they are smeared with dye and inspected visually for signs of failure. At least five cycles of this test are usually run.

At best the present freezing-and-thawing test gives only an approximate indication of weather resistance. Although it has never been adopted as an industry standard, the test is nevertheless resorted to by many as a minimum precaution.

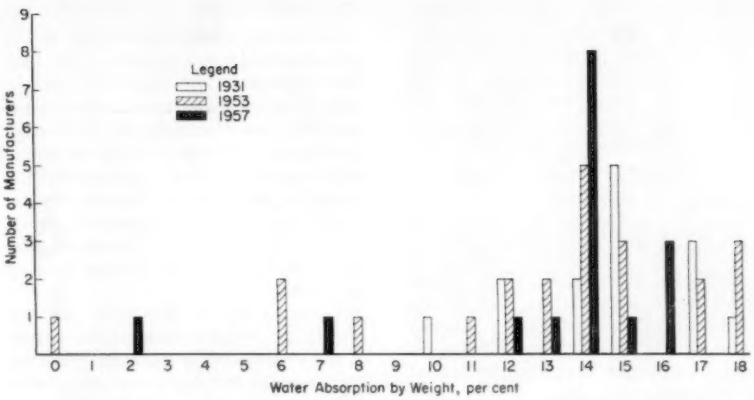

Fig. 1.—Distribution of per cent water absorption for glazed ceramic wall tile produced in 1931, 1953, and 1957.

Abrasive Hardness

A simplified abrasive hardness test has been proposed recently to replace the one in Federal Specification SS-T-308 which requires an abrading apparatus designed at the National Bureau of Standards (**1**)[2] that is rather cumbersome and not generally commercially available. The new test uses the Taber Abraser, a small commercially available instrument.

Tests were run using both machines and a definite correlation was obtained between them so that the results of either instrument may be expressed in terms of the other. Both tests measure the volume of material abraded in a specific abrading cycle.

Wear Service Test

Because certain new types of glazed tile have been found to be suitable for counter tops and floors subject to light traffic, a wear resistance test was devised. It is a practical test which, if applied carefully, can be used with confidence to determine how a floor will stand up in service.

A panel is made and placed in an area where the traffic will be similar to but much more frequent than that expected in service. An electric eye counts the traffic, and the relative wear resistance of the tile is determined by visual inspection. Evaluation of the degree of wear is facilitated by reference to standards.

Because they found it inconvenient

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

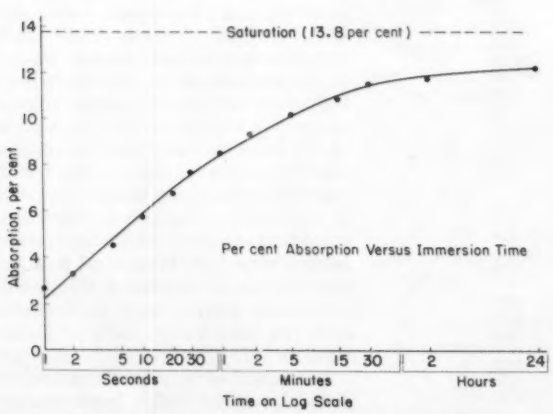

Fig. 2.—Weight per cent water absorption of a typical glazed wall tile as a function of time compared to the saturation limit of 13.8 per cent determined by the standard two-hour immersion in boiling water.

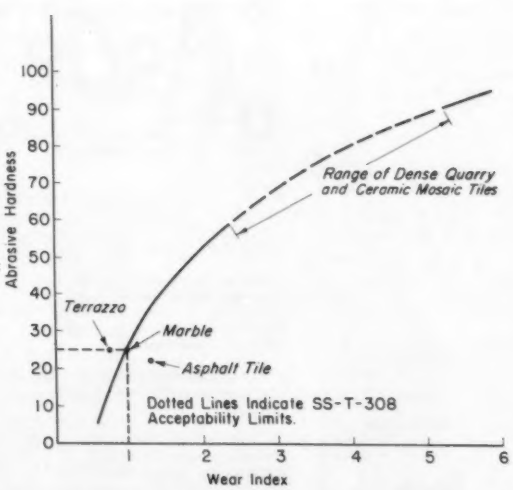

Fig. 3.—Correlation of SS-T-308 abrasive hardness (Ha) with Taber Abraser wear index (Iw) of ceramic floor tile and other common flooring materials.

to carry out a field service test every time a new glaze required wear-resistance evaluation, some manufacturers now are using a much simpler laboratory testing procedure. In this test each tile is exposed for a definite number of revolutions to abrasive-paper-coated wheels on the Taber Abraser.

Hardness

To test hardness, a material harder than tile is required to produce a measurable indentation. The Tukon Tester determines the so-called Knoop Hardness or microhardness by measuring the length of a very small diamond-shaped impression made on the surface by a diamond point (2).

In the operation of the instrument a diamond shaped diamond point is brought slowly and automatically into contact with the test surface under a known but variable load. The indenter also is lifted from the test surface slowly and automatically. The long diagonal of the diamond-shaped indentation is measured using a microscope with a filar eyepiece and a micrometer crosshair.

This test has been used mainly on glazed tile. However, unglazed surfaces such as quarry tile and ceramic mosaics can be tested but must usually be polished to make the diamond impression clearly visible for measurement. J. H. Koenig has published his measurements of the Knoop hardness of dinnerware glazes (3). Knoop hardness numbers of the tile and some other materials are given in Table II.

Scratch Resistance

Ordinarily, scratch resistance of tile poses no problem because only a very few materials are hard enough to scratch it. An approximate test, used for many years in the ceramic industry, consists of drawing a sharp corner of each mineral of Moh's scale slowly across the glazed surface under a pressure of about 25 lb. The scratch resistance is reported as the number of the mineral in Moh's scale nearest the hardness of the glaze.

The results of this test depend greatly on the sharpness of the corner of the mineral being used, the pressure and speed at which the operator draws the mineral across the surface, and other factors.

Some investigators report more consistent results when a freshly broken, sharp piece of the glaze being tested is drawn across the minerals. However, it would appear that the same limiting factors of corner sharpness, pressure, and speed also apply in this case.

Moh's scale of hardness if not quantitative enough to distinguish between small differences in scratch resistance. The Bierbaum Microcharacter instrument has been successfully employed for determining relative scratch resistance or susceptibility of various glazes. In this test, the edge of a polished diamond is drawn at constant rate and pressure to create a scratch or groove the width of which is a measure of susceptibility to scratch.

Resistance to Crazing

This test has been very useful for a number of years in many branches of the ceramic industry but particularly in the tile, terra cotta, glazed structural tile, and dinnerware branches.

Almost everyone has seen glaze on old tile installations or dinnerware which has developed a series of hairline cracks. These cracks usually did not develop until the tile had been in service for at least several years. The crazing test is therefore an accelerated test showing in a matter of hours what can be expected after a number of years of normal service. Development of this test made it possible for tile companies to experiment with their product and improve it without having to wait years to determine whether crazing propensities had been eliminated.

Virtually all glazed wall tile produced in the United States today is highly craze-resistant. Foreign countries, however, still produce tile which craze. Unfortunately, some of this is imported and is a source of consumer complaint. The test consists of placing specimens of tile on a rack above water level in an autoclave. The water in the autoclave is then heated and a steam pressure of 100 psi or more is maintained for 1 hr. The pressure is then released by opening a blow-off valve and the specimens are allowed to cool in the autoclave. When the specimens have cooled to room temperature, they are examined for crazing by rubbing a dye over the glazed face. If crazing is present, the dye will penetrate the craze marks, making them visible.

TABLE II.—MOH AND KNOOP HARDNESS OF VARIOUS MATERIALS INCLUDING MANY COMMON FLOOR AND WALL SURFACING MATERIALS.

Moh's Scale	Surfacing Material	Knoop Hardness
1 Talc	Inlaid linoleum	1.6
	Rubber floor tile	2.2
	Vitreous or cold glaze paint	10
	Asphalt floor tile	16.7
	Plastic wall tile	19
	Plastic enameled aluminum wall tile	29
	Terrazzo (portland cement)	29
	Terrazzo (MgOCl)	34
	White tile grout	25
	Plastic surface coating on concrete tile	37
2 Gypsum	.....	50
3 Calcite	.....	100
	Polished white marble	123
4 Fluorite	.....	150
	Terrazzo black marble chip	196
	Terrazzo white marble chip	204
	Porcelain enameled aluminum wall tile	334
	Porcelain enameled steel wall tile	364
	Polished black marble	425
5 Apatite	.....	430
	Bright glazed wall tile (472–540)	500
	Textured glazed tile (458–630)	533
	Plate glass	550
6 Orthoclase	.....	560
	Matt glazed tile (520–630)	562
	Ceramic mosaic floor tile	667
	Natural clay mosaic floor tile	706
7 Quartz	.....	800
8 Garnet	.....	1600
9 Corundum	.....	2000
10 Diamond	.....	8000

Increasing hardness

Bond Strength

The bond test differs from other standard tile tests in that while not routinely used for tile, it is used to test installation materials and techniques. People connected with the tile industry know that virtually any tile will remain bonded to portland-cement mortars under normal service conditions if proper mortar mixes and installation techniques are used. Nevertheless, when a tile installation problem arises, some try to blame the tile for not bonding properly to the mortar. The idea has been proposed that one brand of tile bonds while another does not. The bond test has been helpful in disproving this belief. In the laboratory, the bond test is mostly used for developing better mortar mixes.

A standard or experimental mortar is placed in square molds approximately the size of the tile. Tile which have been soaked in water and drained of excess water are doped with a skim

coat of neat portland cement ($\frac{1}{32}$ to $\frac{1}{16}$ in. thick) and set in the mortar 1 hr after the mortar has been mixed and placed in the molds. Specimens are then cured under controlled conditions for seven days. The tile are sheared off the mortar on a compression testing machine in which the rate of travel of the moving crosshead is not greater than 0.05 in. per min and the bond strength is then calculated in pounds per square inch.

The specified minimum bond strength contained in Federal Specification SS-T-308 is 50 psi. The bond of neat cement-coated tile usually exceeds 200 psi. However, when the skim coat is omitted the bond of the tile directly to the mortar may be only 25 psi or less. The bond strength of ceramic mosaics under various conditions has been reported in a recent article by Balinkin (**4**).

Slipperiness

The slipperiness of walkway surfacing is important from the point of view of safety. Of two methods for measuring slipperiness one employs an instrument constructed by P. A. Sigler of the National Bureau of Standards (**5,6,7**) which measures the dynamic coefficient of friction of the test surface. It consists of a pendulum to which is attached a spring-loaded test heel (leather or rubber), a pointer which records the swing of the pendulum, and leveling screws to position the instrument properly with respect to the test specimen.

When the instrument has been properly oriented, the pendulum is released from a definite height and the relative slipperiness of the test surface is calculated from the height to which the pendulum rises after passing over the specimen.

The instrument is portable, and, although used mainly in the laboratory, it has also been used to check floors under actual service conditions. The claim is made that the instrument agrees closely with people's observations of whether a floor is slippery when walked on.

The second method employs a machine, used by the Underwriters' Laboratories, which measures essentially the static coefficient of friction. It consists of a 3-in. square leather sole mounted on the bottom of a loaded pivot arm, a movable table on which the specimen is mounted, and a recording chart. The leather sole is placed on the test specimen with the movable table placed so that the loaded pivot arm is vertical. As the table is moved, the angle of the pivot arm keeps increasing until the sole finally slips on the specimen.

Color Matching

The close manufacturing control and rigid inspection procedures followed by ceramic tile manufacturers in the United States today have greatly reduced the once difficult colormatching problem. However, to safeguard the customer a color matching test is still included in Federal Specification SS-T-308.

The test consists of matching color samples provided by the manufacturer with the actual lot of tile to be used. Comparison is made by viewing the samples and tile from the lot at right angles to their surface under the diffuse light of a northern sky.

One company has recently proposed an artficial light source consisting of "Deluxe Daylight" fluorescent lamps behind a diffusing screen for use if the diffused light of a northern sky is not available.

No machine is yet commercially available that can judge minor color variations on a factory production line. Women, whose eyes are claimed to be more perceptive than men, are generally employed for this purpose (**8**). Even so, using the Farnsworth-Munsell 100-hue color tests, a tile company has found that only one woman in five is acceptable as a color inspector.

Thermal Shock

With the increasing use of glazed tile on counter tops, inside radiant heated barbecues, and in fireplaces, the resistance of tile to thermal shock may be important.

The Federal Specification SS-T-308 test for thermal shock consists of placing three tile in an oven maintained at 145 ± 5 C. After 30 min, the tile are removed and quickly placed, glaze up, on a sheet of aluminum (15 by 15 by 0.091 in. supported at corners on 2-in. legs).

After 15 min, the tile are again returned to the oven. This cycle of heating and cooling is repeated five times. The tile must exhibit no evidences of shivering, dunting, or other types of disintegration.

In another shock test, specimens are heated to 212 F and plunged into ice water (36 F or less). Sometimes as many as 25 cycles are run in this test. The method of heating varies. Some place specimens in an oven at room temperature and raise the temperature uniformly to 212 F in 1 hr, maintain at 212 F for 1 hr, and quench specimens. Others boil specimens in water for 10 min, quench in ice water for 4 min, and then put them back in boiling water. The latter allows a great many more cycles to be run in a short period of time.

[3] 1955 Book of ASTM Standards, Part 3, p. 805.

Wedging

Occasionally, as a result of uneven heat treatment or imperfect forming procedures, some of the tile in a lot may be slightly trapezoidal, that is, one edge may be longer than the opposite edge.

Wedging is tested by measuring the lengths of opposite edges of the tile to the nearest 0.01 in. and is reported as the difference in lengths divided by the average length of the measured sides.

Federal Specification SS-T-308 states that wedging for standard grade tile shall not exceed 0.005 in. per in.

Warpage

Federal Specification SS-T-308 test for warpage uses a straight edge and feeler gage or other suitable equipment. Measurements are made on the face of the tile along each edge to the nearest 0.002 in., and warpage is reported as the measured variation from the plane divided by the edge length. Variations from the diagonal line may also be included as a measure of warpage.

Another method employs a three-point support to determine the plane of the tile and a centrally located dial indicator to determine deviation from this plane.

Thermal Expansion

The extent to which a material expands or contracts with changes in temperature is important in any type of construction. A knowledge of the coefficients of thermal expansion of the various materials used is necessary to plan structures intelligently and to determine the necessary placement of expansion joints in these structures.

Thermal expansion of tile can be measured in any apparatus generally accepted for this purpose such as the one described in the Bureau of Standards *Circular 486*, "Thermal Expansion of Solids" or described in ASTM Method of Test for Linear Thermal Expansion of Fired Whiteware Products by the Dilatometer Method (C 372 – 56.)[3]

Test specimens should have a cross-section between 0.05 and 0.2 sq in. and should be between 2 and 8 in. in length. The specimen is inserted in a furnace capable of being heated at a rate of not more than 3 C per min and the expansion and temperature are recorded at least every 50 C.

The coefficient of expansion, e, over any temperature range tested may be calculated from the following formula:

$$e = \frac{L_2 - L_1}{L_1 (T_2 - T_1)}$$

where:

L_1 = length at temperature T_1, and
L_2 = length at temperature T_2.

Radioactivity

The durability and sanitary properties of ceramic tile have made them particularly suited for surfacing hospital and laboratory rooms and corridors. The increasing use of radioisotopes in both research and therapy has brought attention to the fact that some ceramic glazes containing uranium colorants are radioactive. The radioactivity has been known to raise the background count of a room to 10 times the normal background count (9). This, of course, presents a problem when small quantities of radioactivity are being measured.

Radioactive ingredients are much less used in ceramic glazes in the United States due to Government restrictions on raw materials. However, many foreign manufacturers sending tile into the U.S. do freely use radioactive colorants. Such tile should not be used in hospital and laboratory locations.

The radioactivity of a tile can be determined very simply by placing the window of a Geiger-Müller tube over the glazed surface and comparing the count obtained with the normal background count.

Modulus of Rupture

The modulus of rupture (or transverse strength test as it is sometimes called) is important because ceramic tile and, in particular, glazed wall tile must be strong enough to withstand the stresses to which they may be subjected in structures.

The test may be run on any suitable hydraulic, screw, or loaded beam type tester, preferably one which can be loaded at a constant rate not in excess of 40 lb per min. The specimen is supported on two line-contact type supports and the load applied at the midpoint of the support span with a third line-contact type support. If one side of the tile is glazed, the glazed face shall always be in the same position during testing. At least nine pieces should be broken and the results averaged.

The modulus of rupture of square or rectangular specimens is found from the following formula:

$$\text{Modulus of rupture} = \frac{3Pl}{2bd^2}$$

where:

P = load, lb.
l = length of span, in.
b = width of specimen, in., and
d = depth of specimen, in.

This test differs in certain essential details from the ASTM Tentative Method of Test for Modulus of Rupture of Fired Cast or Extruded Whiteware Products (C 369 – 56).[4] Nevertheless, the ASTM test is useful to tile manufacturers who wish to test their clay body materials under standard conditions.

Tensile Strength

It is believed that when ceramic materials fail they generally fail in tension. Therefore, the tensile strength of these materials is more important than is generally recognized.

Tension tests have always been a problem in the ceramic industry because of the need for specially shaped specimens and the stresses produced by the specimen grippers. Nevertheless, ASTM Committee C-21 on Ceramic Whitewares has recently proposed a tentative test for measurement of tensile strength of ceramic whitewares which is also suitable for ceramic tile bodies.

Wall tile are frequently designed to withstand a certain amount of tension by stressing the glaze in compression to resist tensile forces to which it may be subjected in service. The degree of prestressing can be measured relatively by a three-point curvature gage.

Impact Strength

This test is frequently used in the tile industry, especially the falling ball type. The tile is usually mounted as it would be in service and a steel ball of a known size and weight is dropped on it from increasing heights until failure occurs. The porcelain enameled utensil industry has adopted a standard impact test of the falling ball type.[5]

ASTM Methods of Test for Impact Resistance of Plastics and Electrical Insulating Materials (D 256 – 52),[6] contains a method using either an Izod or a Charpy type tester. The tile industry has not yet adopted a standard method for impact testing; however, work is being done on impact testing in several branches of the ceramic industry at present.

Compressive Strength

Since ceramic tile are nonload bearing and not normally subjected to high compressive stresses when properly installed, no standard compressive strength test has been devised. When this test is required, a procedure similar to the ASTM Methods of Sampling and Testing Structural Clay Tile (C 112 – 52)[6] can be used.

Some tile manufacturers use a simple compression test on glazed tile to determine the resistance of the glaze to shivering or "flaking-off" the body. The test consists merely in placing whole tile on edge in a suitable testing machine and applying pressure slowly and steadily until failure occurs. No padding is used between the metal press plates and the tile. However, one crosshead should be universally mounted to allow for alignment with the tile specimen. Spacers are commonly ground off tile edges before making this test.

Young's Modulus

Most of the recent model universal testing machines have attachments available which will record stress-strain curves that allow calculation of Young's modulus.

A simple method of determining Young's modulus is used on small specimens. In this case a dial indicator mounted under specimens being tested on a beam type transverse strength testing instrument registers the deflections as functions of load from which data the Young's moduli are calculated.

Electrical Conductivity

Areas in which highly explosive vapors are likely to be present need a surfacing that is slightly conductive in order to eliminate the hazard of static electricity sparks setting off an explosion. Ceramic tile are produced which will effectively perform in this capacity.

A test for conductive tile based on National Fire Protection Assn. (10) No. 56 is being proposed for inclusion in a revision of Federal Specification SS-T-308.

Thermal Conductivity

When tile is used for surfacing cold storage rooms or fireplaces knowledge of thermal conductivity is important.

One method for measuring this property is the guarded hot plate described in ASTM Method C 177.[7] This test is particularly suitable for testing tile since it allows the use of ordinary tile pieces in the test.

Chemical Resistance

No standard test for the chemical resistance of tile glazes has been adopted by the tile industry because almost all glazes are high fired and are, therefore, not normally attacked by the food acids and alkaline detergents encoun-

[4] 1955 Book of ASTM Standards, Part 3, p. 810.
[5] Tentative Method of Test for Impact Resistance of Porcelain Enameled Utensils (C 284 – 51 T), 1955 Book of ASTM Standards, Part 3, p. 854.
[6] 1955 Book of ASTM Standards, Part 3, p. 360.
[7] Method of Test for Thermal Conductivity of Materials by Means of the Guarded Hot Plate, 1955 Book of ASTM Standards, Part 3, p. 1084.

tered on counter tops and other parts of kitchen areas.

However, certain colors are less resistant than others. Therefore most companies run chemical resistance tests on their glazes. There is some variation in the procedures used.

One test recommended by the Tile Industry Research Bureau in 1939 consists of totally immersing specimens in 10 per cent solutions of hydrochloric acid and sodium or potassium hydroxide at room temperature for 3 hr, after which the specimens are removed, rinsed, dried, and examined visually for evidence of attack.

The Porcelain Enamel Inst. has developed a standard test for acid resistance of porcelain enamels which uses citric acid and gives detailed information for examining specimens and grading them into five classes according to their acid-resistance characteristics.

Efflorescence

The infrequently observed efflorescence on quarry tile floors usually comes from soluble salts in the mortar. In some rare cases soluble salts are present in the tile itself and in order to determine this they are tested in the following manner:

Pieces of tile which have not been wet previously are placed in distilled water so that approximately $\frac{2}{3}$ of their length is submerged. The partially submerged specimens are placed in a suitable dust-free location at about 25 C for a total of at least 7 days of relative humidity less than 25 per cent (original water level is maintained by adding distilled water when necessary). After the 7 days the specimens are dried and compared with unimmersed specimens and the approximate amount and color of any efflorescence is reported.

Bulk Specific Gravity

The bulk specific gravity test (ASTM C 329 – 56)[8] is used in running the abrasive hardness test and measures the specific gravity of the material including all pores. It is measured by weighing the specimens dry, boiling them in distilled water for 2 hr, allowing them to cool, and getting the suspended and saturated weights of the specimens.

Calculation is made from the formula:

$$B = \frac{W_d}{W_s - S}$$

where:

B = bulk specific gravity,
W_d = dry weight,
W_s = saturated weight, and
S = suspended weight.

Specular Gloss

The specular gloss test (ASTM Method C 346 – 55 T)[9] is used to measure the mirroring effect of glazes. Glazes of low specular gloss produced less glare and fewer highlights in the presence of light beams. Therefore, in certain applications where glare is undesirable, tile of low specular gloss are needed.

Other Tests

Many other tests are used in checking the materials used in the application of tile on the job such as the ASTM standard test methods for portland cement, lime, and sand. There is also a Department of Commerce Commercial Standard test for tile adhesives (CS 181 – 52). However, the discussion of these tests is beyond the scope of this paper.

Engineering Properties of Ceramic Wall and Floor Tile

The following is a summary of the engineering properties of domestic ceramic wall and floor tile conforming to Federal Specification SS-T-308 and Simplified Practice Specifications SPR-61. In many instances, properties of other common surfacing materials are given. Also, some properties of mortars used with tile are listed.

TABLE III.—APPROXIMATE WEIGHT PER UNIT AREA OF CERAMIC TILE.

Type of Tile	Thickness, in.	Weight, lb per sq ft
Glazed wall tile	$\frac{1}{8}$	3
Ceramic mosaics	$\frac{1}{4}$	2.5
Quarry tile	$\frac{3}{4}$	8.6
Quarry tile	$\frac{1}{2}$	5.8

TABLE IV.—WATER ABSORPTION OF CERAMIC TILE.

Type of Tile	Water Absorption in Weight, per cent
Glazed wall tile	0 to 18
Ceramic mosaics, porcelain type	0 to 0.5
Ceramic mosaics, natural clay type	0 to 5
Quarry tile	0 to 5

TABLE V.—BULK SPECIFIC GRAVITY OF CERAMIC TILE.

Type of Tile	Specific Gravity
Glazed wall tile	2.0
Ceramic mosaics, porcelain	2.4
Ceramic mosaics, natural clay	2.4
Quarry tile	2.2–2.4

[8] Method of Test for Specific Gravity of Fired Ceramic Whiteware, 1955 Book of ASTM Standards, Part 3, p. 815.

[9] Tentative Method of Test for 45-Deg Specular Gloss of Ceramic Materials, 1955 Book of ASTM Standards, Part 3, p. 862.

TABLE VI.—WEAR RESISTANCE OF CERAMIC TILE AND OTHER COMMON FLOORING MATERIALS.

Flooring Material	Table Wear Index[a]
Ceramic mosaics, porcelain type	5.3
Ceramic mosaics, porcelain type 15 per cent SiC	5.6
Ceramic mosaics, natural clay type	4.0
Paver tile	5.3
Quarry tile, 0–0.5 per cent water absorption	5.0–3.7
Quarry tile, 4 per cent water absorption	2.4
Asphalt tile	1.3
Linoleum	1.3
Marble	1.0
Terrazzo	0.75
Vinyl tile	3.8
Oak parquet flooring	2.1
Cork	0.4
Rubber tile	0.5

[a] Abrasive hardness as per Federal Specification SST-308 can be computed by reference to curve in Fig. 3.

TABLE VII.—28-DAY SHEAR BOND STRENGTH OF CERAMIC TILE TO MORTARS AND ADHESIVES.

	Shear Strength, psi
GLAZED WALL TILE BONDED TO THE FOLLOWING MATERIALS	
No neat cement on 1C: ½L: 4S mortar	25
Resin base ceramic tile adhesives (10)	15–148
Neat cement on 1C: ½L: 4S mortar	200
CS 181-52 conforming ceramic tile adhesives (11)	100–248
Portland-cement mortar containing acrylic emulsion	321
T.C.A. dry curing mortars	450+
Neoprene type tile adhesives	450+
SS-T-308 Federal Spec. requires	50
CS-181-52 U. S. Dept. of Commerce requires	40
CERAMIC MOSAICS BONDED TO THE FOLLOWING MATERIALS (5)	
Neat cement on 1C: 3S mortar (2 beatings)	145
No neat cement on 1C: 3S mortar (2 beatings)	140
Neat cement on 1C: 3S mortar (64 beatings)	430
No neat cement on 1C: 3S mortar (64 beatings)	200
TCA dry curing mortars	155+

TABLE VIII.—DYNAMIC AND STATIC COEFFICIENTS ON FRICTION FOR CERAMIC TILE.

Material Tested	Static Coefficient of Friction[a]	Dynamic[b] Slipperiness Coefficient
Red quarry tile	0.85	0.45
Buff quarry tile	0.89	0.45
Ceramic mosaic 1¼ by 1¼ in. square edge	0.81	0.44
Abrasive surface quarry tile	0.74	0.52
Linoleum	0.76	0.44
Asphalt tile	0.74	0.58
Rubber tile	0.83	0.40

[a] Values above 0.50 considered to be nonslippery.

[b] Values above 0.40 considered to be nonslippery.

TABLE IX.—ROOM TEMPERATURE THERMAL EXPANSION COEFFICIENTSFOR CERAMIC TILE CEMENTS AND MORTARS TAKEN FROM VARIOUS SOURCES.

	Coefficients, in. per in. per deg Fahr	Coefficient, in. per in. per deg Cent.
Neat cement	10 to 12 × 10^{-6}	18 to 22 × 10^{-6}
Neat cement dry	6.7	12
Neat cement 60 per cent sat.	12.	22
Neat cement 100 per cent sat.	6.0	11
1C:2.25S:0.45C/W	4 to 6.3	7 to 11
1C:3S	4.2 to 5.3	7.6 to 11
1L:3S	4.1 to 5.3	7.4 to 9.5
1MC:3C	3.8 to 6.0	6.8 to 10.8
1C:1L:6S	4.7	8.4
Quartz aggregate	5.6 to 8.0	10 to 14
Limestone aggregate	1.2 to 4.5	2.2 to 8
Steel	6.1	11.4
Glazed wall tile	4 to 4.7	7 to 8.4
Ceramic mosaics, porcelain	2.2	4
Ceramic mosaics, natural clay	2.2 to 4.1	4.0 to 7.3
Quarry tile, 0 to 4.8 per cent water absorption	2.2 to 4.1	4.0 to 7.3
Brick, 4.2 to 9.0 per cent water absorption	3.7 to 3.8	7
Brick, 18.4 to 25.1 per cent water absorption	6.8 to 8.5	12 to 15

TABLE X.—MEAN THERMAL EXPANSION COEFFICIENTS OF TYPICAL TILE, IN. PER IN. PER DEG CENT.

Type of Tile	Absorption, per cent	25 to 100 C	100 to 200 C	200 to 300 C	300 to 400 C	400 to 500 C
Quarry	0.1	7.3 × 10^{-6}	7.3 × 10^{-6}	7.5 × 10^{-6}	8.6 × 10^{-6}	10.6 × 10^{-6}
Quarry	0.4	5.6	6.4	6.9	7.8	7.4
Quarry	4.7	7.1	7.1	7.1	7.3	9.1
Wall tile	16	8.4	18.0	9.3	6.8	6.9
Wall tile	13	7.0	13.0	7.6	6.4	7.0

TABLE XI.—MODULUS OF RUPTURE OF CERAMIC TILE, PSI.

Glazed wall tile	24 per cent water absorption (Spanish)	1 900
	18 per cent water absorption (USA)	1 900
	Average of all USA glazed wall tile 1953	3 600
	14 per cent water absorption (USA)	6 200
Ceramic mosaics	porcelain type	7 000 to 11 000
	natural clay type	3 000 to 6 000
Quarry tile	0.5 per cent	5 000 to 8 000
	5 per cent	3 000 to 6 000
Slate		7 700
Marble		1 400
Granite		1 850

TABLE XII.—MODULUS OF ELASTICITY (YOUNG'S MODULUS), PSI.

Glazed wall tile	140 000 to 500 000
Ceramic mosaics	100 000
Quarry tile 0.5 per cent	700 000
Brick	200 000 to 700 000
Slate	140 000
Marble	800 000
Granite	730 000

TABLE XIII.—TENSILE STRENGTH OF CERAMIC TILE BODIES, PSI.

Glazed wall tile		900 to 2500
Ceramic mosaics	porcelain type	3000 to 4200
	natural clay type	1300 to 2500
Quarry tile	0.5 per cent water absorption	2000 to 3300
	5 per cent water absorption	1300 to 2500

TABLE XIV.—COMPRESSIVE STRENGTHS OF CERAMIC TILE BODIES AND RELATED MATERIALS, PSI.

Brick		4 000 to 10 000
Slate		14 000
Marble		12 700
Granite		19 400
Glazed wall tile		8 000 to 22 000
Ceramic mosaics	porcelain type	27 000 to 37 000
	natural clay type	12 000 to 23 000
Quarry tile	0.5 per cent water absorption	18 000 to 30 000
	5 per cent water absorption	10 000 to 22 000

TABLE XV.—THERMAL CONDUCTIVITIES OF CERAMIC TILE AND OTHER COMMON SURFACING MATERIALS

Material	K in Btu/per ft per hr sq ft deg Fahr
Cork	0.025
Rubber	0.087
Leather sole	0.09
Oak wood	0.12
Plaster board (1/2 in.)	0.2
Concrete, cinder	0.2
Gypsum plaster	0.27
Glass	0.3
Brick	0.4
Concrete (1C:4S)	0.44
Cement plaster	0.7
Slate	0.86
Tile, porcelain	0.88
Terrazzo	1.0
Marble	1.4
Steel	26.00

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(3) J. H. Koenig, "Comparison of Some Properties of Plastic and China Tableware," *Ceramic Age*, No. 59 (4), pp. 15–29, 64–72 (1952).

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Determination of the Apparent Density of Hydraulic Cement in Water Using a Vacuum Pycnometer

By C. L. FORD

It has been found by various investigators: (*a*) that the volume of the cement in plastic concrete is less than the theoretical value when the calculations are based on the density of cement as determined in kerosine by ASTM Method C 188 – 44,[1] and (*b*) that the amount of entrained air is also low on the same basis. A method was developed some years ago, and later modified by the present author, to obtain the density of cement in water. Possible objections to the method are discussed. A table is shown giving individual, average, and comparative results by kerosine and water methods.

THERE is at present an ASTM method for the determination of the specific gravity (or density) of portland cement in kerosine.[1] Some years ago the need was felt for knowing the apparent density of cement in water. A method and apparatus was developed which served the purpose, but the apparatus was difficult to manipulate to obtain reproducible results rapidly. It was later modified by the present author to a form which would more certainly give good results. The purpose of this report is (*a*) to show reasons why effective density in water values are needed; (*b*) to refute possible objections to values obtained by the method; (*c*) to present comparative test data; and (*d*) to present (see Appendix) a detailed description of the apparatus and a working procedure for the analyst.

Need for a Water Density Method

The standard method for the determination of the density of hydraulic cement is described in ASTM Method C 188 – 44. In this method the weight of a sample of cement in grams is divided by the volume of kerosine in milliliters it displaces in a Le Chatelier flask to give the specific gravity. This value is also the approximately true density of the cement.

Studies of certain properties of cement mortars and concretes have shown that data calculated using the density as determined in kerosine are less accurate than similar data using the density measured by immersion in water. Under the latter condition a somewhat higher density value is obtained under conditions more nearly resembling those existing in the presence of water in concrete. This value will be referred to as the effective density in water or apparent density.

It was found by Powers (1)[2] that the kerosine density values gave incorrect results when used to measure the space apparently occupied by cement in concrete. He stated that a contraction takes place when cement is mixed with water, which does not occur with kerosine, resulting in an apparent increase in the density of the cement. The contraction was due, among other causes, to the solubility in water of some of the cement constituents and to cement hydration.

Others have found that the apparent density values obtained in water gave more accurate results in computing the air content of concrete and mortar. Menzel (2) experimented with several methods of determining the air content of concrete. He found that a method (ASTM Method C 138 – 44[3]) involving density values gave better correlation with other methods when the water densities were used. The air contents were about 0.20 percentage points higher than those based on kerosine density values. Later Taylor (3) worked on methods for determining the air content of cement mortars. He used an assumed average kerosine density value of 3.15 in the tests that involved the inclusion of densities in the calculations. These tests gave somewhat lower air content values than those obtained by two other methods. He states that had actual water density values been used the calculated air contents would have been 0.140 to 0.214 percentage points higher. Pearson (4) has also reported results similar to those obtained by Menzel and Taylor. In work with concrete of low air content, Verbeck (5) has found that the use of kerosine density values in the calculation of air content has resulted in negative values of from 0.5 to 1.0 percentage ponits.

Procedure

The method used by Powers and his co-workers for the determination of the density of cement in water was described by Brownyard (6) in 1940. Part of the technique of the method was modified later by the author to the form presented in the Appendix. The procedure consists basically of the introduction of about 40 g of cement through an attached large-bore stopcock into a 50-ml Erlenmeyer flask of predetermined weight and volume. (The volume of the flask and stopcock assemblies used in these laboratories is about 55 to 60 ml.) The flask is then evacuated and water introduced to replace the air. It is then brought to a known temperature in a constant temperature bath, and weighed. The apparent density is calculated from the weight, in grams, and the apparent displacement, in milliliters, of the cement.

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NOTE.—DISCUSSION OF THIS PAPER IS INVITED, either for publication or for the attention of the author. Address all communications to ASTM Headquarters, 1916 Race St., Philadelphia 3, Pa.

[1] Method of Test for Specific Gravity of Hydraulic Cement (C 188 – 44), 1955 Book of ASTM Standards, Part 3, p. 186.

[2] The boldface numbers in parentheses refer to the list of references appended to this paper.

[3] Method of Test for Weight per Cubic Foot, Yield, and Air Content (Gravimetric) of Concrete (C 138 – 44), 1955 Book of ASTM Standards, Part 3, p. 1382.

The use of vacuum is required to remove air before the introduction of water because of the difficulty of removing air bubbles otherwise from a relatively large amount of cement in a relatively small amount of water.

Sources of Error

It is recognized that in this method the ratio (1.0 to 1.2) of water to cement by weight is greater than that in a well-designed mortar or concrete, (0.45 to 0.65). On the other hand it is much less than it would be if water were used in the conventional Le Chatelier flask method; hence the errors due to increased reaction with a larger proportion of water are less. Reference to a series of density determinations by Brownyard **(7)** indicates that the error does not exceed 0.01.

It is further recognized that the apparent density increases with time of exposure to water. The most rapid increase occurs during the first 5 to 10 min, after which it is relatively slow for the next 1 to 2 hr. Since air entrainment measurements are made with plastic mortars or concretes, usually not sooner than 10 min after mixing, the densities as determined after the approximately 30 min consumed by the effective density in water test will be comparable to those at the time air entrainment tests are made.

Comparative Test Data

Data showing differences between effective densities in kerosine and water are presented in Table I. All five types of portland cement, including some air-entraining cements, are represented. The averages of individual tests of the Long-Time Study (LTS) cements are repeated from a report by Lerch and Ford **(8)**. Individual test data have been added to show the good reproducibility of results by the water method. It will be noted that the average effective density in water for the seventeen type I and IA cements is 0.057 g per ml higher than the average kerosine

TABLE I.—COMPARATIVE DENSITY OF CEMENT IN KEROSINE AND IN WATER.

Cement Number	Density, g per ml									Difference
	Kerosine					Water				
	Test				Average	Test			Average	
	1	*2*	*3*	*4*		*1*	*2*	*3*		
TYPE I AND IA										
17596	3.128	3.133	3.131	...	3.131	3.188	3.193	3.189	3.190	0.059
17775	3.158	3.156	...	...	3.157	3.212	3.222	...	3.217	0.060
17776	3.151	3.155	...	...	3.153	3.218	3.217	...	3.218	0.065
18171	3.125	3.125	...	...	3.125	3.188	3.185	3.189	3.187	0.062
18377	3.136	3.138	...	...	3.137	3.187	3.192	...	3.190	0.053
LTS[a] 11	3.150	3.148	3.153	...	3.150	3.207	3.207	...	3.207	0.057
LTS 11T	3.151	3.148	3.156	...	3.152	3.209	3.211	...	3.210	0.058
LTS 12	3.176	3.179	3.176	...	3.177	3.236	3.240	...	3.238	0.061
LTS 12T	3.181	3.181	3.181	...	3.181	3.236	3.235	...	3.236	0.055
LTS 13	3.114	3.112	3.114	...	3.113	3.160	3.152	3.147	3.153	0.040
LTS 14	3.179	3.181	3.188	...	3.183	3.257	(3.246)[b]	3.255	3.256	0.073
LTS 15	3.119	3.125	3.122	...	3.122	3.169	3.167	...	3.168	0.046
LTS 16	3.176	3.178	3.176	...	3.177	3.233	3.236	3.235	3.235	0.058
LTS 16T	3.174	3.174	3.178	...	3.175	3.225	3.229	3.230	3.228	0.053
LTS 17	3.173	3.173	3.166	...	3.171	3.240	3.233	3.235	3.236	0.065
LTS 18	3.145	3.147	...	...	3.146	3.198	3.195	...	3.197	0.051
LTS 18T	3.160	3.158	3.156	...	3.158	3.204	3.201	3.200	3.202	0.044
	Average				3.153				3.210	0.057
TYPE II AND IIA										
LTS 21	3.198	3.200	...	...	3.199	3.230	3.228	...	3.229	0.030
LTS 21T	3.202	3.205	...	...	3.204	3.240	3.237	...	3.239	0.035
LTS 22	3.215	3.212	3.214	...	3.214	3.273	3.276	...	3.275	0.061
LTS 23	3.209	3.210	3.209	...	3.209	3.252	3.253	3.253	3.253	0.044
LTS 24	3.176	3.174	3.173	...	3.174	(3.260)	3.251	3.250	3.251	0.077
LTS 25	3.250	3.243	...	...	3.246	3.310	3.302	3.300	3.304	0.058
	Average				3.208				3.259	0.051
TYPE III AND IIIA										
LTS 31	3.135	3.136	3.133	...	3.135	3.211	3.209	...	3.210	0.075
LTS 33	3.097	3.097	3.105	3.107	3.102	3.161	3.166	...	3.164	0.062
LTS 33T	3.109	3.109	3.109	...	3.109	3.178	3.174	...	3.176	0.067
LTS 34	3.156	3.156	3.155	...	3.156	3.202	3.202	3.201	3.202	0.046
	Average				3.126				3.188	0.062
TYPE IV										
LTS 41	3.222	3.222	3.221	...	3.222	3.297	3.296	...	3.297	0.075
LTS 42	3.221	3.226	3.226	...	3.224	3.259	3.262	3.262	3.261	0.037
LTS 43	3.217	3.214	3.226	3.228	3.221	3.294	3.300	3.294	3.296	0.075
LTS 43A[c]	3.226	3.222	3.222	...	3.223	3.275	(3.294)	3.273	3.274	0.051
	Average				3.223				3.282	0.059
TYPE V										
LTS 51	3.210	3.209	3.210	...	3.210	3.252	3.253	3.254	3.253	0.043
	Average				3.210				3.253	0.043
	Grand Average				3.171				3.227	0.056

[a] Long-Time Study cements analyzed in 1941. At that time the letter "T" following the number was used to designate air-entraining (type 1A) cements.

[b] Values in parentheses are not included in averages.

[c] This "A" does not signify air-entraining cement, but a different lot from the same mill as LTS 43.

density, with a maximum variation of from 0.040 to 0.073 g per ml. The average difference in density for all five types of cement is 0.056 g per ml. From these average values it may be suggested that for approximate calculations of air content, a value of about 0.056 could be added to the kerosine density values—at least for type I and IA cements.

Summary

A method is presented for the determination of the apparent density of hydraulic cement in water. This method is preferable to the kerosine method for obtaining densities values to be used in the calculation of the space occupied by the cement in concrete or for the calculation of the air content of concrete. Comparative data for 32 cements show an average increase of 0.056 g per ml when density tests are made in water instead of kerosine.

References

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(8) William Lerch and C. L. Ford, "Long-Time Study of Cement Performance, Chapter 3, Chemical and Physical Tests of the Cements," *Journal*, Am. Concrete Inst., Vol. 17 (8) April, 1948, p. 762; *Proceedings*, p. 44; *Research Bulletin*, Portland Cement Assn., No. 26, Aug., 1948.

APPENDIX

A METHOD FOR THE DETERMINATION OF CEMENT DENSITY IN WATER USING A VACUUM PYCNOMETER[4]

Scope

1. This method of test is intended for determining the apparent density of cement in water. This apparent density approximates more closely the density of the cement when in contact with water in concrete. (While not applicable to concrete, the density of cement in any other liquid may be obtained with the proper modifications in converting weights to volumes.)

Apparatus

2. (*a*) Vacuum pycnometer made by joining a 50-ml Erlenmeyer flask to a stopcock (Note 1) of 6-mm bore. To the other end of the stopcock is joined the inner part of a 14/35 ground glass joint as shown in Fig. 1. For efficient work at least three of these pycnometers should be available.

(*b*) Connecting assembly consisting of the outer portion of a 14/35 ground glass joint connected below a 100-ml separatory funnel with a small-bore inner tube to supply water to the pycnometer, and a side arm and three-way stopcock (Note 1) for connection to either a vacuum pump or to the atmosphere, as shown in Fig. 1.

(*c*) Water trap in a Dewar flask filled about ¼ full with methanol or ethanol, then with dry ice to about ¾ full. The water trap is inserted in the vacuum line between the three-way stopcock and the vacuum pump.

(*d*) Funnel with 5 mm outside diameter, stem about 15 cm long.

(*e*) Vacuum pump (0.3 μ of mercury or less).

NOTE 1.—High-vacuum stopcocks and high-vacuum lubricant should be used throughout.

Calibration of Pycnometers

3. (*a*) Be sure that the pycnometers are clean and dry (see section 3.(*d*) and 4.(*f*) for methods). Weigh the first one to the nearest milligram and record as pycnometer, empty. Connect to vacuum apparatus. Close separatory funnel stopcock, and open three-way stopcock to pump, start pump and evacuate 5 min. During this time weigh the second pycnometer.

(*b*) Fill the separatory funnel with freshly boiled and cooled distilled water.

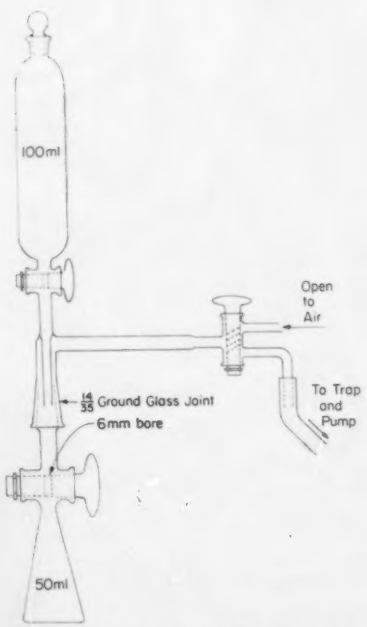

Fig. 1.—Vacuum pycnometer apparatus.

At the end of the 5-min evacuation period, close the stopcock to the pump and carefully open the separatory funnel stopcock until the pycnometer is filled to a little above its stopcock. When effervescence of the water has nearly ceased, open the three-way stopcock to the air, remove the pycnometer and with the aid of a clamp immerse it up to the stopcock for 30 min in a constant temperature (preferably several degrees above room temperature) bath, with the stopcock still open. Record the water temperature.

(*c*) During the 30-min period, proceed as above with the second and third pycnometers. At the end of the 30-min period, close the pycnometer stopcock, remove from the bath and dry the outside with a towel. Empty the excess water from the tube above the stopcock, then carefully dry the interior of the tube with absorbent tissue such as Kleenex. Weigh and record as pycnometer plus water. Follow the same procedure with the second and third pycnometers.

(*d*) After weighing, shake the water from the pycnometers, insert a small glass tube connected to the laboratory vacuum line, and draw air through until dry. Drying may be accelerated by rinsing the pycnometers once or twice with acetone before applying suction.

Procedure

4.(*a*) Weigh the first clean, dry pycnometer and record as pycnometer, empty (separate recording from that used in calibration). Weigh roughly in a weighing pan approximately 40 g of cement. Clamp the pycnometer to a support stand and insert the funnel. Transfer the cement to the pycnometer using a No. 16

[4] This method is based on one developed by T. L. Brownyard, May, 1940.

bare copper wire to help force the cement through the funnel stem. Weigh and record as pycnometer plus cement.

(*b*) Be sure that the separatory funnel stopcock is closed and that the connecting tube beneath it is free of water. Connect the pycnometer to the vacuum apparatus. Close the three-way stopcock to the vacuum pump and start the pump. Open the three-way stopcock very cautiously to prevent drawing the cement out of the pycnometer flask. It is sometimes helpful also to tap the flask very lightly. Evacuate for 15 to 20 min for ordinary cements or 30 min for air-entraining cements.

(*c*) During the evacuation period weigh the second pycnometer, add cement and reweigh.

(*d*) At the end of the evacuation period, close the three-way stopcock to the pump and fill the pycnometer with water. (If any air bubbles appear, evacuation was not complete and the test must be repeated.) Place in the constant temperature bath for 30 min. Record the water temperature. Dry and weigh as described under "Calibration of Pycnometer," section 3.(*c*). Record the weight as pycnometer plus cement plus water.

(*e*) During the 30-min period, carry on the procedure as described above successively with the second and third pycnometers.

(*f*) Clean the pycnometers as soon as possible after the weights with cement and water are obtained. If the cement is allowed to set, the pycnometers will be ruined. The cleaning may be done as follows:

Invert (stopcock open), shake out some of the water, close the stopcock, shake until all the cement is loosened from the bottom, open the stopcock and shake out as much of the slurry as possible. Insert a small glass tube connected to a water line (same tube that was used for drying), turn on the water and flush well. Shake out the water, then with the aid of the funnel, partially fill with dilute hydrochloric acid (1-1), shake and empty. Rinse first with city water injected through the glass tube then with distilled water. Dry as described under "Calibration of Pycnometers," section 3.(*d*).

Calculations

5. Calculate the density of the cement according to the method illustrated by the sample calculations shown below:

DETERMINATION OF VOLUME OF PYNOMETER

1.	Weight of pycnometer filled with water	170.045 g
2.	Weight of pycnometer empty	115.205 g
3.	Weight of water to fill pycnometer (item 1 − item 2)	54.840 g
4.	Temperature of water	28.5 C
5.	Specific volume of water (handbook)	1.00390 ml per g
6.	Volume of pycnometer (item 3 × item 5)	55.054 ml

DETERMINATION OF DENSITY OF CEMENT IN WATER

7.	Weight of pycnometer empty	115.204 g
8.	Weight of pycnometer + cement	155.217 g
9.	Weight of pycnometer + cement + water	197.526 g
10.	Temperature of water	28.5 C
11.	Weight of cement (item 8 − item 7)	40.013 g
12.	Weight of water (item 9 − item 8)	42.309 g
13.	Specific volume of water (handbook)	1.00390 ml per g
14.	Volume of water (item 12 × item 13)	42.474 ml
15.	Volume of pycnometer, empty (item 6)	55.054 ml
16.	Volume of cement (item 15 − item 14)	12.580 ml
17.	Density of cement (item 11 ÷ item 16)	3.181 g per ml

Discussion of Paper on a New Coal Plastometer[1]

C. S. FINNEY.[2]—I have read with great interest D. C. Hills' paper on "A New Coal Plastometer." My interest was due to the increasing dissatisfaction I had begun to feel with the performance of our Gieseler plastometer after but a few months' experience with the apparatus in the fuel laboratory here at Shortland.

One of our tasks at this newly established organization is to investigate the possibilities of improving the quality of the blast-furnace coke produced at the Newcastle and Port Kembla Steelworks of the Broken Hill Proprietary Co., Ltd. Hence our interest in the plastic behavior of coal.

Our early experiences with the Gieseler plastometer some six months ago were not particularly encouraging, but I assumed this to be more the result of our inexperience than an indication of any inherent shortcomings in the Gieseler apparatus itself. Thanks to D. C. Hills' very candid account of the troubles which he and others experienced, I now realize that our suspicions about the Gieseler plastometer were only too well founded.

One of the things which most dismayed us was the fact that time and again the packing would fail to hold—this despite every care taken in preparing the sample, packing the crucible, assembling the retort and attaching it to the plastometer head. We have found that upon release of the brake the pointer raced merrily around. Quite apart from the packing, we found the technique of using the Gieseler plastometer with highly fluid coals most difficult indeed. Even on those occasions when I felt reasonably happy with the timing of a rapidly moving pointer, and was satisfied that the business of rewinding the string had not interfered with the test, I could not believe that the maximum fluidities we recorded measured any property of the coal other than how much of it was left in the crucible! We also found frequent evidence of slippage, but regarded this as the least of our troubles.

I heartily congratulate the author upon the modifications he has made to eliminate the worst features of the Gieseler plastometer. To be able to carry out one test per hour with the reproducibility quoted is indeed a triumph. The thing which perhaps impressed me most was the elimination of the thermal lag inherent in a solder bath. I would not have believed that direct heating by means of gas flames could give the required temperature uniformity, and the author's success with this method underlines yet again the importance of keeping one's mind quite open to ideas other than those well accepted.

Although we are redesigning the loading device, I am afraid that at this juncture we shall not be able to attempt such refinements as the use of a hysteresis brake or the use of direct gas heating. Instead of the standard loading device, we shall use the whole of the upper part of the retort as the packing agency. The retort barrel will slide in a sleeve machined to very close tolerance. To the lower (wider) end of the barrel, two packing attachments will be fitted. The first of these will be a suitably slotted piston attachment which will be used to pack coal between the rabble arms to a height somewhat above the top arm. This first packing head will then be removed and the second solid head used to pack the remaining coal, it too being removed after the charge has been consolidated. During these operations the stirrer will be firmly held by what we may term a "needle valve" which screws down into a tapered hole drilled into the top of the stirrer shaft. The "needle valve" will not be released from engagement with the stirrer shaft until the barrel has been screwed on to the crucible.

Those of us who are more or less new to plastometry must indeed be grateful to Mr. Hills for his contribution and also to his enlightened employers in Indianapolis for their support in a program of investigation.

[1] D. C. Hills, "A New Coal Plastometer," ASTM BULLETIN, No. 218, Dec., 1956, p. 34 (TP 212).

[2] Senior Research Officer, The Broken Hill Proprietary Co., Ltd., Central Research Laboratories, Shortland, New South Wales (Australia).

Corrosion of Concrete by Sulfuric Acid

By W. C. HANSEN, R. P. VELLINES and W. W. BRANDVOLD

Results of a study of methods designed to evaluate the resistance of portland-cement mortars to attack by sulfuric acid in sanitary sewers indicate that the attack may consist of corrosion by the acid and of expansion by reaction of calcium sulfate with tricalcium aluminate

CONCRETE is used at times under conditions where it is subjected to attack by acids. Such an exposure is found in sanitary sewers in which hydrogen sulfide, released by the sewage to the air above the liquid, is oxidized to sulfurous and sulfuric acids. The strength of the acid solution condensed on the crown of the sewer pipe probably varies over a considerable range. Also, during storms, the sewer may be completely filled with liquid carrying some sand which may remove by abrasion any coating formed on the surface of the pipe by the reaction with acid. Likewise, there may be times when the sewer carries very little liquid and the concrete above the liquid may become fairly dry. Because of these possible variations in the conditions to which the concrete may be exposed, it is difficult to outline a method of testing that will yield results entirely comparable to those obtained in service.

The engineer responsible for designing concrete for service in sewers must select the most suitable type of cement for his concrete. The project described in this report was undertaken in an effort to develop realistic methods of testing cements for this service and to compare the resistance to attack by sulfuric acid of mortars made from types I, IS, and II cements.

TABLE I.—OXIDE AND CALCULATED COMPOSITIONS OF CEMENTS.

	Type I	Type II	Type IS
SiO_2	20.5	21.7	25.5
Al_2O_3	6.6	5.8	9.3
Fe_2O_3	2.8	4.5	1.9
CaO	63.1	62.1	53.3
MgO	2.8	2.1	4.4
SO_3	2.3	1.9	2.5
Loss on ignition	0.90	0.92	1.7
K_2O	0.40	0.42	0.30
Na_2O	0.07	0.06	0.07
$3CaO \cdot SiO_2$	46.0	36.9	...
$2CaO \cdot SiO_2$	24.2	34.5	...
$3CaO \cdot Al_2O_3$	12.7	7.7	...
$4CaO \cdot Al_2O_3 \cdot Fe_2O_3$	8.5	3.7	...

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Experimental

Tests with 2 by 4-in. Cylinder Specimens

Three commercial cements were used. Two were a type I and a type IS cement made in one plant from its regular type I cement clinker. The third was a type II cement from the same plant. The compositions of the three cements and the calculated compound compositions of the types I and II cements are given in Table I.

Two sets, I and II, of 2 by 4-in. cylindrical mortar specimens were made for each of the three cements. Set I, consisting of four specimens for each cement was made with natural sand from Elgin, Ill., and set II, consisting of two specimens for each cement, was made with sand composed of a mixture of equal portions of graded and standard Ottawa sands.

The mix proportions were 1:2.215 by weight, and the water content was 46.9 per cent by weight of cement. The molds were filled and tamped in three equal layers. The tamper was made of maple wood and had a square cross-section of $\frac{5}{8}$ in. and a length of 6 in.

The specimens were cured in the moist cabinet for one day, removed from the molds, and stored in water at approx-

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R. P. VELLINES, manager, Research Laboratories, has been engaged in physical testing of cement and concrete since starting with the Universal Atlas Cement Co. id 1936. He received a B.S. in Chemical Engineering in 1935 from West Virginia University.

W. W. BRANDVOLD, section leader, Research Laboratories, graduated from the South Dakota State School of Mines in 1937, with a B.S. degree in Chemical Engineering. After graduation, he worked for the South Dakota State Highway Department, the City of Huron, S. D. Engineering Department, and as an Ordnance Engineer at Aberdeen Proving Grounds. He started work for the Universal Atlas Cement Co. in 1945 and is, at present, in charge of the Concrete Laboratory.

imately 70 F from 34 to 38 days. During molding, a plastic hook was inserted in the specimen for use in suspending the specimens in the acid baths. The types of exposure to which the specimens were subjected are described below.

Tank A.—One specimen for each cement from each of sets I and II was submerged in approximately 0.055 *N* sulfuric acid solution (pH of about 1.5) and stored in a room maintained at 68 to 81 F. The specimens were scrubbed with a nylon brush once a week and were weighed at the end of each four-week period. The strength of the acid was maintained by adding fresh acid each week after determining the amount required by titration. The solution in the bath was not changed during the first 32 weeks of the test period. It seemed that the salts in the solution were markedly retarding the rate at which the acid was attacking the specimens. Therefore, the solution was replaced by fresh acid at the end of the 32-week period, at the end of the 36 and 40-week periods, and then at the end of each week. This changing of the acid greatly accelerated the rate at which the specimens were attacked. Table II gives data for loss in weight of the specimens during a 52-week period and Figs. 1 and 2 show the appearances of the specimens made with the natural sand at the ends of the 37- and 52-week periods. The specimens made with type I cement broke during the 47th week.

Tank B.—Two specimens for each cement from set I were exposed in tank B. In this test, the specimens were dried for 24 hr at 100 F and weighed for the initial weight. They were then immersed in the 0.055 *N* sulfuric acid for three days, immersed in water for three days, and then dried for one day at 100 F. This cycle was repeated, and some of the data for loss in weight determined at the end of each drying period are given in Table III. The manner of handling the acid was identical with that given above for tank A. The appearances of the specimens at the end of the 37- and 52-week periods are shown in Figs. 3 and 4.

Tank C.—One specimen for each cement from each of sets I and II was immersed in this tank in the 0.055 *N* sulfuric acid. The manner of handling the acid was identical with that given for tank A. The specimens were brushed with a nylon brush at the end of each working day, Monday through Friday. Data for loss in weight are given in Table IV, and the appearances of the specimens made with Elgin sand at the ends of the 37- and 52-week periods are shown in Figs. 5 and 6. The specimen made with type I cement broke during the 34th week. The appearance of the specimens made with Ottawa sand at the end of the 37-week period is shown in Fig. 7.

As may be seen from the data, the specimens made with the two sands behaved very much alike. Hence, except for Fig. 7, which is included to show this similarity, only the photographs of the specimens made with Elgin sand are given in this report.

Fig. 1.—Specimens made from Elgin sand and cement types I, IS, and II (left to right) after 37 weeks in 0.055 *N* sulfuric acid. Specimens scrubbed with nylon brush once a week.

Type I specimen broke after 47 weeks.

Fig. 2.—Specimens made from Elgin sand and cement types I, IS, and II (left to right) after 52 weeks in 0.055 *N* sulfuric acid. Specimens scrubbed with nylon brush once a week.

TABLE II.—LOSS IN WEIGHT OF 2 BY 4-IN. CYLINDER SPECIMENS IN TANK A.

Type of Cement	Source of Sand	Loss[a] in Weight, per cent						
		8 Weeks	16 Weeks	24 Weeks	32 Weeks	40 Weeks	48 Weeks	52 Weeks
IS	Elgin	0.7	−0.1	−0.5	−0.1	2.8	25.0	34.1
IS	Ottawa	1.1	−0.1	−0.8	−0.4	2.9	26.3	36.1
I	Elgin	0.9	−0.2	−1.7	−2.0	−0.9	[b]	...
I	Ottawa	0.8	−0.9	−8.0	−11.7	[b]	...	...
II	Elgin	1.1	0.9	0.8	1.2	3.2	19.9	28.7
II	Ottawa	1.0	0.6	0.4	0.7	2.9	22.2	29.8

[a] Negative values are gains in weight.
[b] Specimen broke during handling.

Fig. 3.—Specimens made from Elgin sand and cement types I, IS, and II (left to right) after 37 weeks in 0.055 *N* sulfuric acid. Specimens subjected to weekly treatment of 3 days in acid, 3 days in water, and 1 day in 100 F oven.

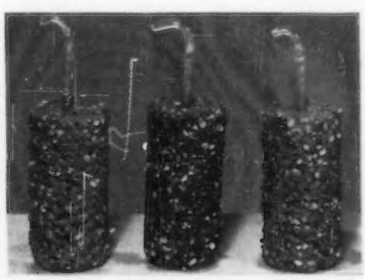
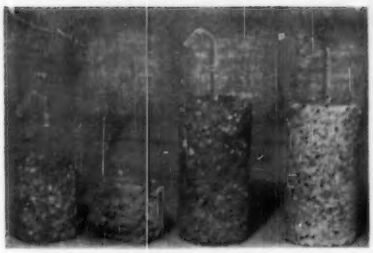


Fig. 4.—Specimens made from Elgin sand and cement types I, IS, and II (left to right) after 52 weeks in 0.055 *N* sulfuric acid. Specimens subjected to weekly treatment of 3 days in acid, 3 days in water, and 1 day in 100 F oven.

TABLE III.—LOSS IN WEIGHT OF 2 BY 4-IN. CYLINDER SPECIMENS STORED IN TANK B.

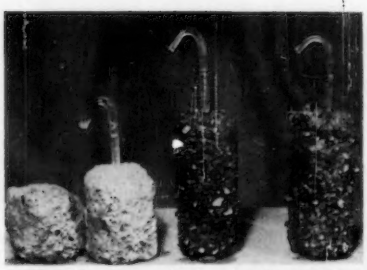
Type of Cement	Identification of Specimen	Loss[a] in Weight, per cent						
		8 Weeks	17 Weeks	24 Weeks	32 Weeks	40 Weeks	48 Weeks	52 Weeks
IS	1	0.4	0.6	0.2	1.3	2.1	17.7	26.0
IS	2	0.8	1.2	0.7	1.6	3.0	18.4	27.1
I	1	0.3	0.4	−0.1	1.0	2.1	16.1	22.4
I	2	0.4	0.4	0.1	1.0	2.2	17.0	22.9
II	1	0.1	0.2	−0.1	1.1	2.4	14.7	20.7
II	2	−0.2	0.2	−0.2	1.2	2.7	16.2	21.9

[a] Negative values are gains in weight.



Type I specimen broke after 34 weeks.

Fig. 5.—Specimens made from Elgin sand and cement types I, IS, and II (left to right) after 37 weeks in 0.055 *N* sulfuric acid. Specimens scrubbed with nylon brush 5 times a week.



Type I specimen broke after 34 weeks.

Fig. 6.—Specimens made from Elgin sand and cement types I, IS, and II (left to right) after 52 weeks in 0.055 *N* sulfuric acid. Specimens scrubbed with nylon brush 5 times a week.

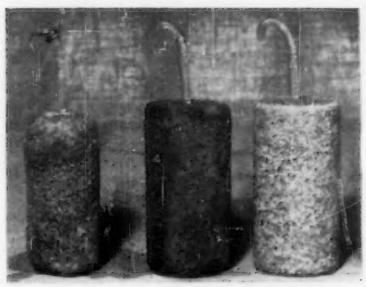


Fig. 7.—Specimens made from Ottawa Silica sand and cement types I, IS, and II (left to right) after 37 weeks in 0.055 *N* sulfuric acid. Specimens scrubbed with nylon brush 5 times a week.

TABLE IV.—LOSS IN WEIGHT OF 2 BY 4-IN. CYLINDER SPECIMENS IN TANK C.

Type of Cement	Source of Sand	Loss[a] in Weight, per cent						
		8 Weeks	16 Weeks	24 Weeks	32 Weeks	40 Weeks	48 Weeks	52 Weeks
IS	Elgin	1.6	1.6	3.6	5.8	13.8	40.6	52.4
IS	Ottawa	1.2	1.4	4.3	7.1	16.4	[b]	...
I	Elgin	1.3	0.9	0.7	−1.7	[b]	...	...
I	Ottawa	1.1	0.3	0.5	4.6	42.6	[b]	...
II	Elgin	1.4	1.6	3.5	4.6	9.8	32.8	46.2
II	Ottawa	1.1	1.2	3.1	3.7	10.8	33.2	[b]

[a] Negative values are gains in weight.
[b] Specimens broke during handling.

Tests with Mortar Pipe Specimens

Two 6 by 12-in. mortar pipes were made with each cement and Elgin sand. A form 3 by $10\frac{1}{2}$ in. was placed inside a 6 by 12-in. steel cylinder mold and a 1:2.215 mortar with 30.4 per cent water by weight of cement was tamped into this form to produce a pipe. A view of the pipes, assembled in a wheel in which they were rotated, is shown in Fig. 8.

The pipes were cured for 48 hr in a fog room, 15 days under water, and 35 days in air while filled with water. In the test, the pipes partially filled with 500 ml of the 0.055 *N* sulfuric acid were rotated continuously, except for the time required for changing solutions and weighing. The acid was replaced with fresh acid each working day. Every seventh day, the acid was replaced with 500 ml of water containing 200 g of natural sand. After being rotated for 24 hr, the pipes were flushed with water and weighed. Data for loss in weight are given in Table IV.

Discussion of Results

An effort was made in this study to simulate the exposures to which concrete might be subjected in a sanitary sewer. It appears from some of the figures (see Fig. 1) that the specimens are attacked in two ways. The first is the gradual corrosion of the specimen by the acid. The second is an expansion and spalling off of a layer from the surface of the specimen. This second type of attack was observed only on the specimens made with type I cement stored in tanks A and C. It seems that this type of attack might be classed as sulfate-attack. That is, it appears that the calcium sulfate formed by the reaction of this acid with the cement has reacted with the tricalcium aluminate in the cement to produce an expansion. The type I cement contained 12.5 per cent tricalcium aluminate by the conventional way of calculating compound composition.

The type IS cement used in this investigation consisted of approximately 40 parts blast-furnace slag and 60 parts type I clinker. It appears from the results of this study that this cement is as resistant to sulfate-attack as is the type II cement used in this investigation.

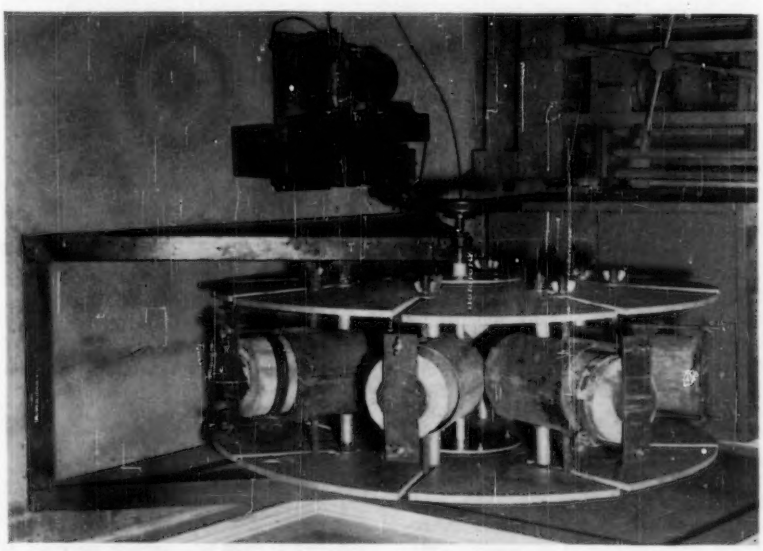


Fig. 8.—Assembly of pipe specimens in rotating wheel.

TABLE V.—LOSS IN WEIGHT OF PIPE SPECIMENS.

Type of Cement	Identification of Specimen	Loss in Weight, per cent						
		8 Weeks	16 Weeks	24 Weeks	32 Weeks	40 Weeks	48 Weeks	52 Weeks
IS	1	0.4	0.8	1.2	1.7	2.1	2.5	...
IS	2	0.6	1.2	1.7	2.2	2.6	3.0	...
I	1	0.7	1.3	1.8	2.4	2.7	3.1	...
I	2	0.8	1.3	1.8	2.4	2.8	3.2	...
II	1	0.6	1.2	1.8	2.4	2.8	3.3	...
II	2	0.7	1.4	1.8	2.4	2.8	3.2	...

Both appear to have good resistance to sulfate attack.

Scrubbing the specimens five times a week increased the rates at which they lost weight. However, the specimens made with type I cement showed a rather marked degree of sulfate-attack in both treatments.

The procedure followed with the specimens in tank B has not shown any marked differences between the cements. One feature of this treatment was that the coatings formed on the specimens during immersion in acid were converted to powders during drying. These fell off when the specimens were reimmersed. The specimens made with type I cement do not show the sulfate-attack in this exposure. This may be because of the leaching of the sulfates from the specimens during the immersion in water and the loss of sulfate from the surface caused by the drying.

The results of the tests with the pipes have not shown any marked differences between the cements. This treatment probably approaches more nearly than any of the others the exposure of concrete pipe in sewers.

Under the conditions where sulfate attack was not observed (see Tables III and V), the specimens lost weight at about the same rate regardless of the type of cement. Hence, it appears that the differences in the compositions of these cements were not sufficient to cause marked differences in the rates of corrosion. The results in Table II and IV show that exposure to sulfuric acid can progress from a straight corrosive attack to a combination of corrosion and sulfate attack.

It appears that, if a sewer flows completely full for a period of one or two days each week, the attack from sulfuric acid would be largely corrosive. In such service, one type of cement should give about the same performance as another. If the sewer flows only partially full for relatively long periods of time, the attack could be both corrosive and sulfate-attack. In this case, it seems that a cement should be selected on the basis of resistance to sulfate. It appears that, of the procedures studied in this investigation, the one followed for tank A is the most satisfactory for detecting the resistance to sulfate-attack. However, it probably would be desirable to modify this method to the extent of changing the acid each week instead of leaving it unchanged for a long period of time, as was done in the early period of this investigation.

Acknowledgment:

The authors wish to express their appreciation to John Deets for his development of the apparatus and the supervision of the tests.

Behavior of Certain Alloys Subjected to Dynamic Loading

By RALPH G. CRUM and F. T. MAVIS

This paper describes a spring-powered impact apparatus and a data recording system for dynamic tension tests of 0.25-in. diameter specimens. Specimens of steel, aluminum, and titanium alloys were tested statically, and dynamically at constant or slightly increasing velocity from impact to fracture in approximately 1.5 millisec. The tests show that yield and ultimate strengths are greater for dynamic loading than for static loading. The ductility of specimens of a given material was essentially the same whether the specimens were loaded statically or dynamically.

A THEORY of propagation of plastic deformation in solids was proposed by von Karman in 1941. This theory related the motion of particles and the stress-strain diagram for the material (1).[1] Subsequent tests have shown deviations from this theory if the static stress-strain curve is assumed throughout the dynamic loading cycle. There is a delay in plastic deformation since the velocity of the plastic strain wave is finite. There are other differences in behavior of materials loaded dynamically and statically as evidenced by tests. A selected bibliography is appended (2–6).

This paper describes a versatile apparatus for making tensile impact tests. It presents data from static and dynamic tests of three grades of steel, three grades of aluminum, and a titanium alloy.

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[1] The boldface numbers in parentheses refer to the list of references appended to this paper.

Apparatus

The loading apparatus finally chosen, among several alternatives considered, was a mechanical ram actuated by a loaded helical spring. For the initial studies the spring had a modulus of 1250 lb per in. and a displacement of 11 in., providing a maximum velocity of 900 in. per sec. Springs are interchangeable for different capacities, displacements, and moduli.

Figure 1 shows an exploded view of the apparatus. Plunger *A*, was mounted inside the spring, *B*. It was guided by plates *C*, which pass over the plunger, and by sleeve-struts *D* and *E*, which bear on plates *C*. End caps, *F* and *G*, keep the sleeve-struts, *D* and *E*, from coming off the ends of the plunger. The rod *H*, attaches by ball and socket joints to cap *G* at one end, and to one chuck which holds the specimen at the other. The mechanism is then held in the housing, *I*, by end plates, *J*, and the tie rods, *K*. The housing is fastened to the moving head of a universal testing machine. Accordingly, the plunger may be pushed or pulled into the cocked position from either end and tripped by a release mechanism.

RALPH G. CRUM, assistant professor of civil engineering, Carnegie Institute of Technology, Pittsburgh, Pa., has been actively engaged in the study of the response of materials to dynamic loads for a number of years. His major fields of interest include materials testing, applied mechanics, and structural research.

F. T. MAVIS, Dean of the College of Engineering and professor of civil engineering at the University of Maryland, College Park, Md. From 1944 to 1957 he was professor and head of civil engineering at Carnegie Institute of Technology. He has published extensively in hydraulic engineering, structural analysis, and applied mechanics.

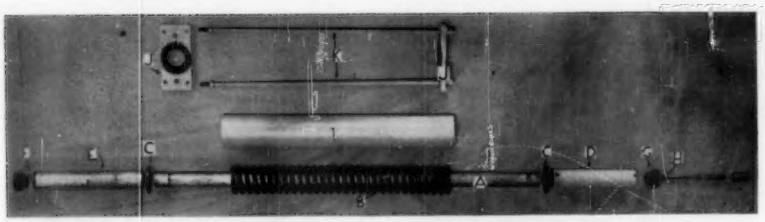

Fig. 1.—Exploded view of loading apparatus.

Figure 2 shows the apparatus in loading position with the ram vertical.

Figure 3 shows a specimen in the machine ready for testing.

Sketches of typical specimens A and B are shown in Fig. 4.

Each load cell shown in Fig. 3 consists of four 500-ohm C-1 SR-4 electrical resistance strain gages cemented to a bar of Ti-150A titanium alloy 0.50-in. in diameter. This bar has a static proportional limit of 92,000 psi and an elastic modulus of 15.5×10^6 psi. During initial tests, stresses in the bar did not exceed 30,000 psi—less than one third of the static yield stress. Strains were measured by two 120-ohm A-12 SR-4 electric resistance strain gages attached to opposite sides of the specimen.

After the load cells were calibrated statically, specimens of each material were tested statically and dynamically. The dynamic modulus of elasticity for each material was the same as its static value.

In subsequent tests, loads were measured on the specimen itself by SR-4 strain gages attached to the 0.50-in. diameter sections of specimens B, immediately adjacent to the strain-measuring section.

While the behavior of the strain gages under dynamic loading conditions was not checked experimentally, it seemed from analyses that for the tests reported in this paper the errors in measurements indicated by the gages would not be significant.

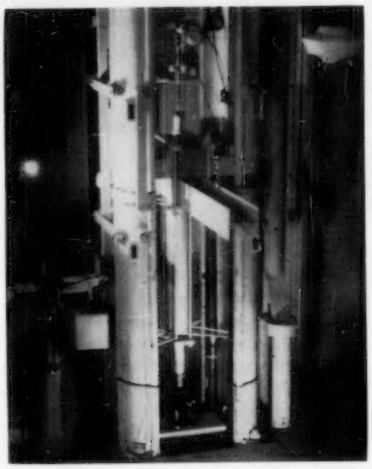

Fig. 2.—General view of testing machine assembly.

Velocity of Impact

To determine the striking velocities, high-speed motion-picture photographs were made of the plunger with no specimen attached. From the photographs, displacement-time and velocity-time graphs were plotted. Finally, the velocity-displacement graph shown in Fig. 5 was obtained. The initial slope of the velocity-time curve indicates a maximum acceleration of 90,000 in. per sec per sec, or 230 times the acceleration of gravity.

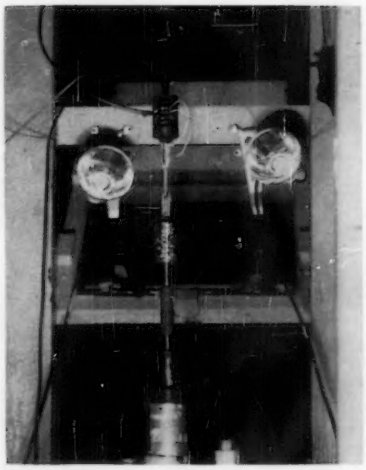

Fig. 3.—Detail of specimen, chucks, and exposed plunger.

Recording Apparatus

SR-4 electrical resistance strain gages were used in Wheatstone bridge circuits to measure loads, reactions, and strains. The unbalanced voltages caused by a change in resistance of the measuring gages were measured by the vertical deflection plates of cathode-ray oscilloscopes. SR-4 strain gages were used for the dummy resistances of the Wheatstone bridge circuit to prevent lag in recordings at the fast loading rate of these tests.

An Eastman high-speed motion picture camera was used to photograph the specimens during a dynamic test and to record the oscilloscope traces. This camera photographs up to 3000 frames per sec through a front lens and rotating optical shutter. Simultaneously it records a continuous trace of an oscilloscope "dot" through the back

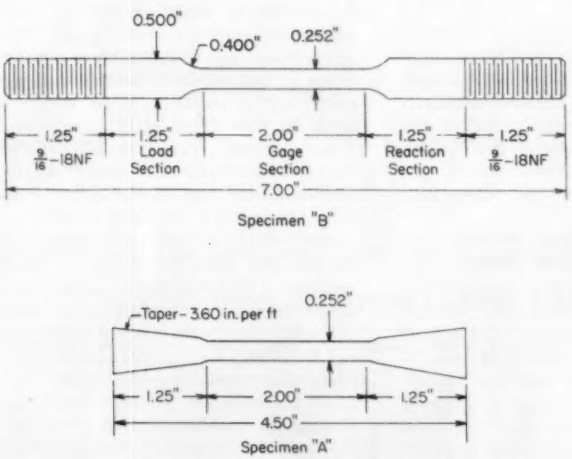

Fig. 4.—Details of specimens.

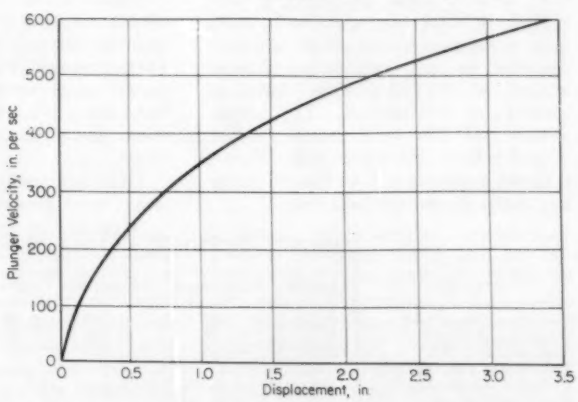

Fig. 5.—Velocity-displacement data for plunger moving freely.

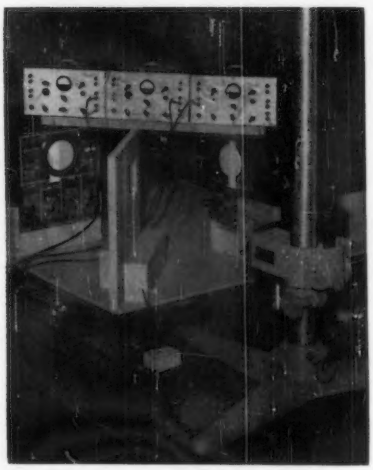

Fig. 6.—Recording apparatus in operating position.

of the film by way of a side lens and dichroic mirror. Thus all data were synchronized on one strip of film. An argon lamp, actuated by 60-cycle current, marks a time trace on the edge of the film.

Specimens were lighted by two 750-R GE reflector floods at 14 in. DuPont 931-A film was used for all tests and developed as negative in a Morse G-3 rewind tank about 15 min, in DK60A at 68 F. The side lens was a Cine Ektar 63-mm f/2 at full aperture, and the front lens a Cine Ektar 120-mm f/2.7 generally set at f/4 on an image reflected by a front surface mirror. Camera speeds were usually 1200 frames per sec.

Data recorded during tests were (1) load on an elastic section on the *load* side of the specimen, (2) strain on the gage section of the specimen, and (3) reaction on an elastic section on the *reaction* side of the specimen. One Dumont model 333 dual-beam oscilloscope measured strain and reaction; another model 304-A oscilloscope measured load. These oscilloscopes were placed at right angles to each other with a dichroic mirror (beam splitter) placed at 45 deg to each to superimpose images of the oscilloscope faces as viewed by the camera. The mirror passes half the light which reaches it and reflects the other half. Figure 6 shows a photograph of the recording apparatus in position for a test.

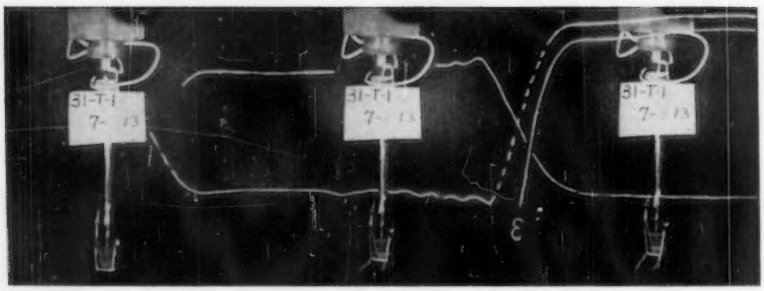

Fig. 7.—Typical photographic record.

Materials Tested

Seven materials were tested as noted:

1. Structural-grade steel, ordinarily used for beams, columns, and other rolled shapes.
2. Intermediate-grade steel, used primarily for concrete reinforcement.
3. Hard-grade steel, also used principally for concrete reinforcement.
4. Aluminum alloy 7075-T6, a high-strength alloy used for aircraft structures and high-strength die forgings. It is available in sheet, plate, bar-stock, and extrusions.
5. Aluminum alloy 2024-T4, a fairly high-strength alloy used for aircraft structures, truck wheels, and screw machine parts. It is available in sheet, plate, rods, and extrusions.
6. Aluminum alloy 2014-F, a forging stock that can be heat treated. The tests reported herein were made on material as received.
7. Titanium alloy Ti-150A, a tough, ductile, high-strength alloy with static yield strength of 92,000 psi and static ultimate tensile strength of 140,000 psi.

Table I gives the nominal composition of these materials. All materials were received as either $\frac{5}{8}$-in. or $\frac{3}{4}$-in. bar stock.

Data and Results

Figure 7 shows a typical photographic record obtained from the oscilloscopes. Each specimen to be tested dynamically to destruction was calibrated in the elastic range by a static test beforehand using a conventional testing machine in conjunction with the oscilloscope.

Time lags among load, reaction, and strain were reasoned as follows: The total mass between the load and reaction gages was approximately 0.03 lb/g. The maximum acceleration of the specimen is in the order of 200 g. Therefore, the difference in magnitude between load and reaction should not exceed 6 lb—a negligible amount. The distance between the load and reaction gages is approximately 3 in. The speed of the slowest plastic wave during all but the final stages of the test is about 120,000 in. per sec. Thus, there is a time lag between load and reaction of only 30 μsec. The load and reaction did differ during the last 50 to 100 μsec of the test while the specimens were necking and decreasing in cross-sectional area. Hence, it was somewhat difficult to pin-point exactly the final fracture load.

Stresses and Strains at Yield, Ultimate, and Fracture

The titanium load link and reaction link were never strained beyond the elastic limit. Accordingly, the nominal *stress* in the test specimen was readily determined from the oscilloscope traces of load and reaction on the moving film by dividing forces (as calibrated statically) by the original area of the specimen. *Strain* in the specimen was indicated simultaneously on the moving film as an oscilloscope trace actuated by SR-4 gages on the specimen itself. The strain trace was well defined in the elastic range of the specimen, and it assumed essentially a constant slope with respect to time from yield to fracture. Thus, "stress" and "strain" (except for a constant factor) were automatically plotted on the film in parametric form with time as the common variable.

Stress-strain curves were plotted to an enlarged scale by analyzing these

TABLE I.—CHEMICAL COMPOSITION OF MATERIALS TESTED, PER CENT.

Alloy	Carbon	Manganese	Phosphorus	Sulfur	Copper	Silicon	Magnesium	Zinc	Chromium	Iron	Nitrogen
Structural grade steel	0.24	0.47	0.007	0.03	...	...	...	...	...	...	...
Intermediate grade steel	0.37	0.37	0.009	0.029	...	0.11	...	...	...	...	...
High grade steel	0.74	0.85	0.14	0.31	0.06	0.18	...	...	...	...	...
7075-T-6 aluminum	...	...	...	...	1.6	...	2.5	5.6	0.3	...	...
2024-T-4 aluminum	...	1.5	...	...	4.5	...	0.6	...	...	...	...
2014-F aluminum	...	0.8	...	...	4.4	0.8	0.4	...	...	...	...
Ti-150A titanium alloy	0.046	...	...	...	...	...	...	...	2.68	1.32	0.069

TABLE II.—STATIC AND DYNAMIC PROPERTIES OF MATERIALS TESTED (AVERAGE VALUES).

		Hard Grade Steel	Intermediate Grade Steel	Structural Grade Steel	2014-F Aluminum	7075-T6 Aluminum	2024-T4 Aluminum	Ti-150A Titanium
Specific yield stress, psi	Static	70 000	40 000	40 000	17 000	59 000	41 000	92 000
	Dynamic	125 000	87 500	81 000	28 400	86 500	54 800	240 000
	Ratio of dynamic to static[a]	1.78	2.18	2.02	1.66	1.46	1.33	2.61
Resilient energy, lb-in. per cu in.	Static	83	27	27	14	169	82	272
	Dynamic	264	128	109	40	363	146	1830
	Ratio	3.18	4.74	4.04	2.85	2.14	1.78	6.72
Nominal ultimate strength, psi	Static	142 000	72 700	63 400	38 000	79 900	67 100	140 000
	Dynamic	221 000	128 500	93 500	43 300	100 900	73 700	240 000
	Ratio	1.56	1.77	1.47	1.14	1.26	1.10	1.71
Nominal fracture strain over 1-in. gage length $\left(\frac{L}{D}=4\right)$	Static	0.155	0.37	0.44	0.20	0.20	0.20	0.30
	Dynamic	0.175	0.32	0.455	0.25	0.20	0.25	0.28
	Ratio	1.13	0.87	1.06	1.25	1.00	1.25	0.93
True fracture stress, based on area and load at fracture	Static	181 000	132 000	125 000	58 000	92 200	91 600	234 000
	Dynamic	270 000	190 000	153 000	133 000	135 000	140 000	444 000
	Ratio	1.49	1.44	1.22	2.29	1.46	1.53	1.89
Per cent reduction in area at fracture	Static	29.0	58.0	65.5	42.6	39.6	27.6	60.6
	Dynamic	32.9	49.0	65.6	52.4	34.0	42.0	54.8
	Ratio	1.13	0.85	1.00	1.23	0.86	1.52	0.90
True fracture strain $Ln\left(\frac{A_0}{A}\right)$	Static	0.33	0.84	1.06	0.55	0.50	0.38	0.94
	Dynamic	0.40	0.67	1.06	0.74	0.42	0.54	0.79
	Ratio	1.21	0.80	1.00	1.34	0.84	1.42	0.84

[a] Static rate of loading ranged from 20–60 psi per sec, while dynamic rate of loading varied from 20–60 x 10^8 psi per sec, a ratio of 100 million to one.

parametric curves. The specific yield stress reported in Table II was determined from these large-scale graphs either (*a*) as the stress corresponding to 0.01 per cent strain offset, or (*b*) as the stress at which the slope of the stress-strain curve was three fourths the slope of the curve in the proportional range. The specific yield stresses for a given material determined by methods (*a*) and (*b*) were essentially the same.

Table II summarizes the static and dynamic properties of the specimens of materials tested in this study.

Summary and Conclusions

1. The specific yield stress of each material tested was greater for specimens loaded dynamically than for specimens loaded statically. The ratio of specific yield stresses—dynamic to static—ranged from 1.33 for 2024-T4 aluminum alloy to 2.61 for Ti-150A titanium alloy.

2. The nominal ultimate strength of each material tested was greater for specimens loaded dynamically than for specimens loaded statically. The ratio of nominal ultimate strengths—dynamic to static—ranged from 1.10 for 2024-T4 aluminum to 1.77 for intermediate-grade steel.

3. The ratio of specific yield stress to nominal ultimate strength was greater for specimens loaded dynamically than for specimens loaded statically.

4. For a given material the nominal fracture strain over a 1-in. gage length was substantially the same whether the specimen was loaded dynamically or statically. This has been shown to be true for other materials (**5, 6**). Only specimens of intermediate-grade steel and Ti-150A titanium alloy were less ductile dynamically than statically.

5. For a given material the true fracture stress, based on area and indicated load at fracture, was greater for specimens loaded dynamically than statically.

Acknowledgments:

This paper is based on a thesis directed by F. T. Mavis and submitted by Ralph G. Crum in partial fulfillment of the requirements of the degree, doctor of philosophy, at Carnegie Institute of Technology in 1956, while he was the recipient of a National Science Foundation Fellowship.

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(2) R. O. Belsheim, "Delayed-Yield Time Effects in Mild Steel Under Oscillatory Axial Loads," *Preprint Paper No. 56-A-108,* Am. Soc. Mechanical Engrs. (1957).

(3) F. T. Mavis and M. J. Greaves, "Destructive Impulsive Loading of Reinforced Concrete Beams," *Journal,* Am. Concrete Inst., Vol. 29, No. 3, Sept. 1957, pp. 233–252; *Ibid.* No. 9, Mar. 1958, pp. 811–823.

(4) R. G. Crum and E. D'Appolonia, "Behavior of Ti-75A Titanium Alloy Under Repeated Load," *Proceedings,* Am. Soc. Testing Mats., Vol. 55, p. 969 (1955).

(5) M. J. Manjoine, "Influence of Rate of Strain and Temperature on Yield Stresses of Mild Steel," *Journal of Applied Mechanics, Transactions,* Am. Soc. Mechanical Engrs., Vol. 66, pp. A-211–A-218 (1944).

(6) R. O. Fehr, E. R. Parker, and D. J. DeMichael, "Measurement of Dynamic Stress and Strain in Tensile Test Specimens," *Journal of Applied Mechanics, Transactions,* Am. Soc. Mechanical Engrs., Vol. 66, pp. A-65-A-75 (1944).

Automatic System for Spectrometric Data (*Continued from page 67*)

information, which provides a measurement of the intensity of a spectral line of one of the chemical elements. This electronic read-out system is connected to a card punch so that the data may be automatically recorded on punched cards for input to a high-speed computer.

Operation is fully automatic once the operator has placed the sample in the spectrometer and pushed the starting button. The spectral exposure is made in about 30 seconds; the measurements of spectral line intensities are read into the storage unit in 5 seconds and are punched in a card 5 seconds later. For a set of about 30 samples tested, the resulting punched cards are transferred to the computer, which has been programmed previously to receive and process the data. In 3 minutes the 500 or more measurements for the 18 elements in the samples are converted to percentage concentration; 7 minutes later the statistical analysis of the data is completed and the results typed out in convenient form.

(*Continued on page 96*)

Melting Range of Rubber Chemicals

Prepared by TASK GROUP ON THE ANALYSIS OF RUBBER CHEMICALS[1]

A statistical study of melting range as a criterion for evaluation of several technical-grade rubber chemicals

This report on Melting Ranges of Rubber Chemicals was prepared by the Task Group on the Analysis of Rubber Chemicals of Subcommittee XI of Committee D-11 on Rubber and Rubber-Like Materials. It is of considerable importance to those concerned with the purchase and use of the accelerators and antioxidants covered in the work and, indirectly, as a general method for the evaluation of similar materials. It ties in directly with the Tentative Method of Test Melting Range of Rubber Chemicals[2] prepared by Committee D-11. The paper also exemplifies the use of statistical methods which should be employed more often in the development of such methods.

THE USE of melting point or melting range as an indication of quality of rubber chemicals has long been considered desirable because of the speed and apparent simplicity of the method. In practice, it has proved to be difficult to reproduce, and its reliability has been questioned. A group was formed to resolve this and other analytical problems in the rubber chemicals field. As its initial task, the group proposed to develop standard procedures for determining melting point or melting ranges and to determine the statistical confidence limits of these methods.

Preliminary Studies

A variety of methods of reporting melting temperatures was in use. Some laboratories reported a single temperature such as a meniscus point, a median melting point, or a temperature at completion of melt. Other laboratories reported melting in terms of a range but with a different selection of initial and final melting temperatures. After reviewing all of these, it was concluded that melting range was the more proper description, as the width of the range in itself would give some indication of the homogeneity of the material and would avoid the impression of great precision given by the use of a single figure.

It was thought that the apparatus most capable of providing reproducible results was one employing a liquid bath, a capillary tube in direct contact with the liquid, positive circulation of the bath, and a controlled rate of heating. The use of such an apparatus was checked by two subgroups, one of which reviewed available equipment and the other studied methods of using this equipment on U. S. Pharmacopoeia melting standards. Commercially available apparatus was concluded to be satisfactory. To eliminate sources of variability during studies of reproducibility between the laboratories involved, each laboratory purchased identical equipment.

A method for evaluation was established after task groups had studied operating details, such as the manner of packing of capillary melting point tubes, the effect of varying length and diameter of the capillary tubes, the effect of rate of rise of temperature, and the definition of initial liquefaction temperature. Particular care was taken to describe as carefully as possible the appearance of the material in the capillary tube at the initial point and the final point of the melting range, as it had been found that the selection of these points was difficult.

First Interlaboratory Study

The melting point procedure was then evaluated on representative rubber chemicals. The chemicals selected were: tetraethylthiuram disulfide, phenyl-β-naphthylamine, tetramethylthiuram disulfide, mercaptobenzothiazole disulfide, mercaptobenzothiazole, and zinc dimethyldithiocarbamate.[3] A single large sample of each of these, provided by one of the participating companies, was divided into eight portions and sent to each of eight laboratories represented in the study. Considerable care was taken by the supplying laboratory to be sure that all material was blended uniformly and was protected from all sources of contamination during shipment. Each sample was then analyzed at each of the participating laboratories according to the following experimental design:

	First Day	Second Day	Third Day
Technician A	X, X	X, X	X, X
Technician B	X, X	X, X	X, X
Technician C	X, X	X, X	X, X

The above design calls for eighteen determinations. It represents a single sample analyzed in duplicate by three technicians on each of three different days. Each determination is made singly and independently.

The detailed procedure used by each laboratory in the determination of

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[1] G. C. Maassen, Chairman—R. T. Vanderbilt Co., Inc.; F. C. Betzhold—The Goodyear Tire and Rubber Co., G. S. Cook—E. I. du Pont de Nemours and Co., Inc.; N. C. Somers—E. I. du Pont de Nemours and Co., Inc. E. G. Wiest—E. I. du Pont de Nemours and Co., Inc.; I. Gibbs—R. T. Vanderbilt Co., Inc.; L. Gillette—Industrial Division, Pennsalt Chemicals Corp.; P. J. Mester—Naugatuck Chemical, Division of U. S. Rubber Co.; J. N. Roark—Monsanto Chemical Co.; L. F. Van Eck—American Cyanamid Co.; A. J. Vielhaber—The B. F. Goodrich Chemical Co.

[2] D 1519, accepted February 28, 1958.

[3] *Chemical Abstract* names for these are, respectively: bis(diethylthiocarbamoyl) disulfide, *N*-phenyl-2-naphthylamine, bis(dimethylthiocarbamoyl) disulfide, 2,2′-dithiobisbenzothiazole, 2-mercaptobenzothiazole, zinc dimethyldithiocarbamate.

melting range in this program is described below.

Recommended Method for Determining Melting Range

Equipment

The apparatus shall consist of a device for heating the sample uniformly at a predetermined rate. A suitable device (Fig. 1) consists of a glass H-type melting apparatus, usually called a Hershberg tube. One side-tube contains an agitator blade and an internal heater, both controlled by variable transformers. The thermometer and capillary tubes are placed in the other side tube.[4] The apparatus shall be shielded from drafts. A good light source and magnifying glass shall be used. A suitable heating medium, such as fluid silicone,[5] shall be used as the bath liquid. The liquid must cover the bridge of the apparatus at room temperature.

The capillary tube to contain the sample shall be a glass tube approximately 15 cm long and 1.2 to 1.4 mm in inside diameter with walls 0.2 to 0.3 mm thick and closed at one end.

Thermometers shall be of the partial immersion type and of proper MCA or ASTM range. They shall be divided into subdivisions of 0.5 C or less. Corrections for thermometer should be determined by calibration against a thermometer certified by the National Bureau of Standards.

Procedure

1. If necessary, grind the sample with a mortar and pestle to pass completely through a No. 100 sieve. Use the sample with no further treatment.
2. Select the thermometer of the proper range and support it so that it is immersed to the immersion mark in the liquid of the bath.
3. Charge the capillary glass tube with sufficient powder to form a column in the bottom of the tube about 3 to 6 mm high when packed down as closely as possible by moderate tapping on a solid surface.
4. Heat the bath until a temperature approximately 25 C below the expected melting range is reached. Then regulate the rate of rise so that it averages about 3 C per min for the rest of the determination except that during the actual melting of the sample the rate of rise should be 1 ± 0.2 C per min. When the temperature has risen to about 10 C below the expected melting range, insert the capillary in the bath and adjust the height of the tube so that the material in the capillary is beside the center of the thermometer bulb. The capillary tube should not be placed in the bath previously since many materials undergo decomposition upon prolonged heating. Major adjustments of the heat source should be avoided during the actual melting range.
5. Record the melting range as the temperature range between which liquefaction first becomes evident and the temperature at which no further visual change is observed in the mass.

The initial melting temperature is the temperature at which the first actual formation of liquid occurs, either as a minute drop or as a film. It is not a preliminary contraction, sintering, or darkening. It occurs well before the formation of a meniscus. The liquefaction may occur at the top, bottom, or sides of the sample in the capillary, as well as the rear. When the latter occurs, the point may be missed unless care is taken to watch the rear of the tube; a mirror is a convenient aid for this purpose.

The final melting temperature is the temperature at which no further liquefaction is observed.

6. Report results to the nearest division on the thermometer, after applying necessary calibration corrections.

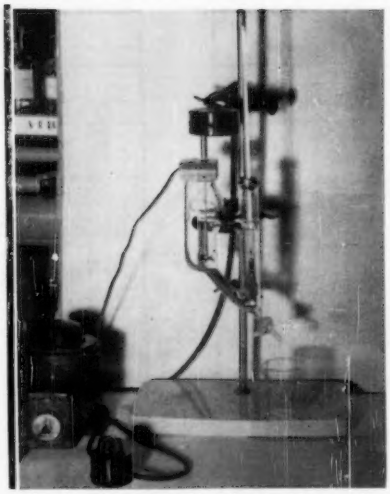


Fig. 1.—Apparatus for determining melting range.

Results of First Study

At the completion of the investigation all data were collected and tabulated. The initial and final temperature data for each compound were analyzed separately using the statistical analysis form shown in Tables I and II. In all cases the analysis showed the variation between the laboratories on both the initial and final temperatures was significantly greater than the variation within a laboratory. In addition, significant variation was found between technicians in the same laboratory and between determinations on different days by the same technician.

A tabulation of the individual data of this first study has not been included in this report for reason of brevity, but

TABLE I.—FORM OF ANALYSIS OF VARIANCE CALCULATIONS.

Mathematical Model:

$$Y_{ijkl} = \mu + C_i + T_{ij} + D_{ik} + (DT)_{ijk} + E_{ijkl}$$

where:

- Y_{ijkl} = observed result,
- μ = grand average,
- C_i = effect of between laboratory differences (i = 1, 2, 3–7),
- T_{ij} = effect of between technician differences (within laboratory) (j = 1, 2, 3),
- D_{ik} = effect of between day differences (within laboratory) (k = 1, 2, 3),
- $(DT)_{ijk}$ = day-technician interaction (within laboratory), and
- E_{ijkl} = random error.

C_i, T_{ij}, D_{ik}, $(DT)_{ijk}$, E_{ijkl} are assumed to be random variables which are independent, normally distributed, with a mean of "0" and variances σC^2, σT^2, σD^2, σDT^2, σ_0^2, respectively.

Analysis of Variance Table

Source	Degrees of Freedom	Sums of Squares, *SS*	Expected Mean Squares
Between laboratories	6	*SS*(*C*)	$\sigma_\epsilon^2 + 18\ \sigma C^2$
Within laboratories	119	Total *SS*-*SS*(*C*)	$\sigma_\epsilon^2 = \sigma_0^2 + 2\ \sigma DT^2 + 6\ \sigma D^2 + 6\ \sigma T^2$
Between technicians	14	*SS*(*T*)	$\sigma_0^2 + 2\ \sigma DT^2 + 6\ \sigma T^2$
Between days	14	*SS*(*D*)	$\sigma_0^2 + 2\ \sigma DT^2 + 6\ \sigma D^2$
$D \times T$	28	*SS*(*DT*)-*SS*(*T*)-*SS*(*D*)	$\sigma_0^2 + 2\ \sigma DT^2$
Duplicate	63	By difference	σ_0^2

TABLE II.—TYPICAL ANALYSIS OF VARIANCE TABLE MERCAPTOBENZOTHIAZOLE—FINAL MELTING TEMPERATURE.

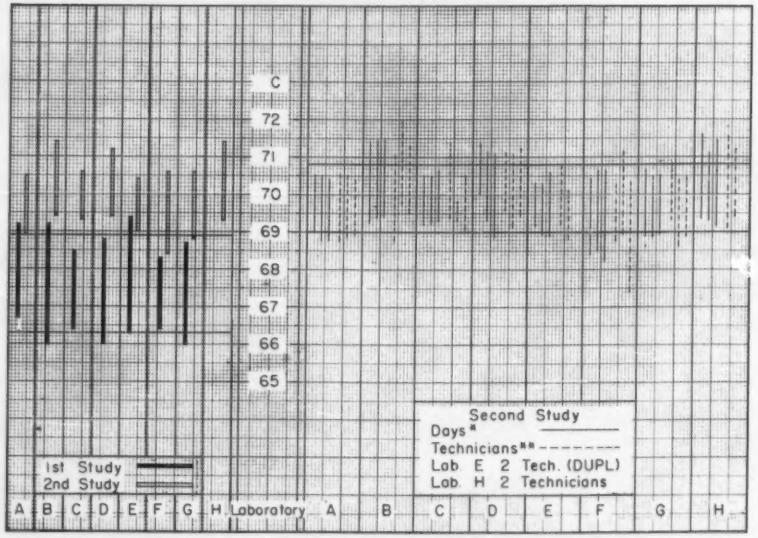
First test, without standards; data coded by subtracting 170 from each value.

Source	Degrees of Freedom	Sums of Squares, *SS*	Mean Squares, *MS*	Expected Mean Squares[d]
Between laboratories	6	9.614	1.602[c]	$\sigma_\epsilon^2 + 18\ \sigma C^2$
Within laboratories	119	15.522	0.130	σ_ϵ^2
Between technicians[a]	14	5.846	0.417[b]	$\sigma_0^2 + 2\ \sigma DT^2 + 6\ \sigma T^2$
Between days[a]	14	3.213	0.229	$\sigma_0^2 + 2\ \sigma DT^2 + 6\ \sigma D^2$
$T \times D$.[a]	28	3.618	0.130[b]	$\sigma_0^2 + 2\ \sigma DT^2$
Random error[a]	63	2.845	0.045	σ_0^2
Total	125	25.137		

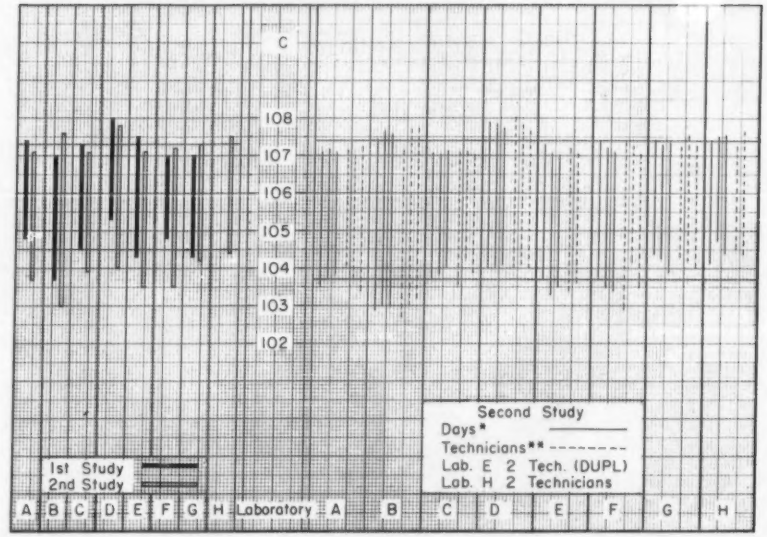
[a] Summation of sums of squares for each laboratory after correction for the laboratory mean.
[b] Significant at the 95 per cent confidence level.
[c] Significant at the 99 per cent confidence level.
[d] Significance tests and variance components for significant factors were estimated as indicated by the expected mean squares. The corresponding degrees of freedom were estimated by the Satterthwaite method. (Reference: Bennett and Franklin, "Statistics in Chemistry and the Chemical Industry," p. 367.) Mean squares that were not significant at the 95 per cent confidence level were pooled as an estimate of σ_0^2. The resulting variance estimates were added to estimate σ_ϵ^2. In most cases, resulting estimates did not differ significantly from σ_ϵ^2 value estimated directly from the within laboratories lines in the analysis of variance tables.

[4] Such an apparatus may be obtained from Eck & Krebs, Inc., and Scientific Glass Apparatus Co., Inc.
[5] Dow Corning DC-550 or General Electric SF-96 silicone fluid is suitable.

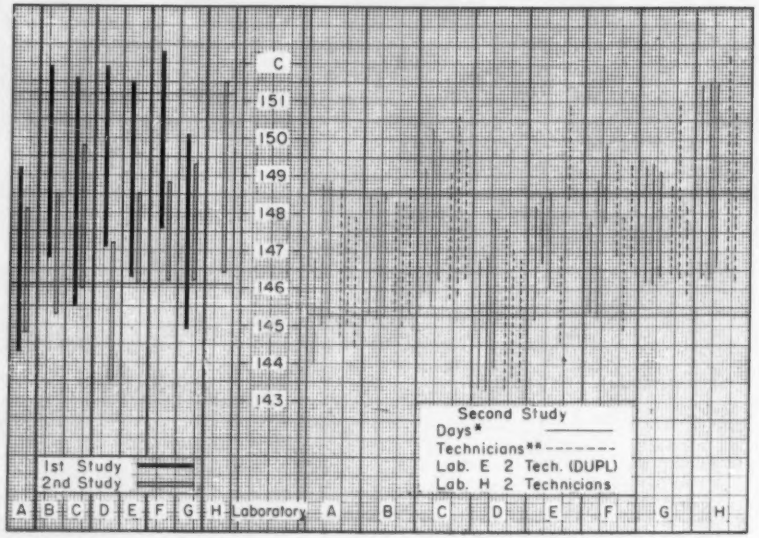
TETRAETHYLTHIURAM DISULFIDE



PHENYL – BETA – NAPHTHYLAMINE



TETRAMETHYLTHIURAM DISULFIDE



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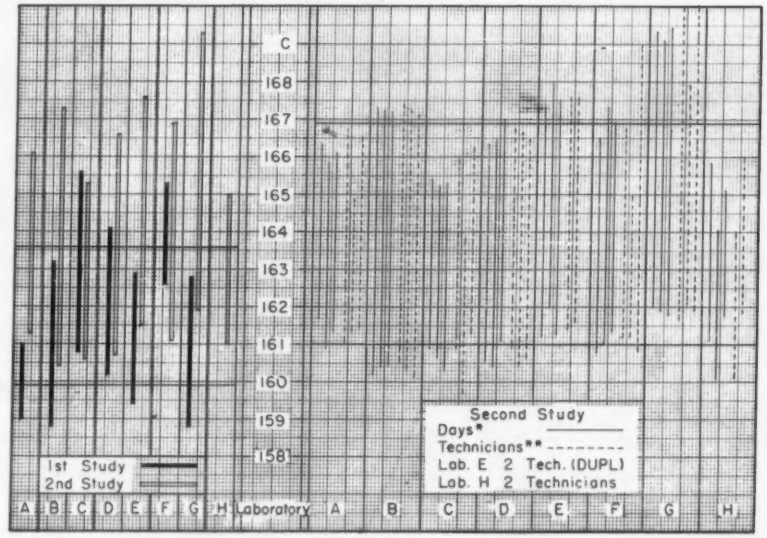

Fig. 2.—Interlaboratory melting point study.

[6] Range for each day determined by averaging each temperature at which the liquefaction of the material is first observed and by averaging each temperature at which no further visual change is observed in the mass, for each determination by all the technicians for a particular day at a particular laboratory.

[7] Range for each technician determined by averaging each temperature at which the liquefaction of the material is first observed and by averaging each temperature at which no further visual change is observed in the mass, for each determination by a particular technician for all the days at a particular laboratory.

melting ranges obtained on each compound by the different laboratories are shown in Figs. 2 to 7.

A review of the data and the opinions expressed by the technicians involved in the experiment indicated that the principal reason for the variation was the difficulty in getting technicians to agree on the points to be designated as the initial and final melting temperatures. The difficulty of obtaining agreement probably was accentuated by slight but important variations in the rate of heating.

The study group concluded that it was most difficult to describe exactly the somewhat indefinite melting conditions at the beginning and end of the melting range. Furthermore, the indefiniteness of these points made them susceptible to change by any slight variation in the conditions of the melting determinations.

Second Interlaboratory Study

To overcome these difficulties, it was proposed to use a standard as a control in the determination; the standard as used by the technician would be run simultaneously with the compound whose melting range was sought. The melting range of both materials would be recorded. A correction applied to the unknown sample would be the difference between the one obtained and the accepted melting range of the standard control material.

The samples used in the completed initial interlaboratory study were adopted as the standard controls. The grand averages of the melting ranges obtained in this study were accepted as the official melting ranges of these standard controls. Different samples of the same six rubber chemicals studied in the first investigation were again supplied by members of the group. Precautions to insure homogeneity and freedom from contamination again were observed. Each laboratory repeated the melting point determinations as run before, using the same design of experiment, but this time running simultaneously the standard and the new or check sample. The correction was determined for the standard and applied algebraically to the check sample as indicated below:

1. Accepted value of standard − observed value of standard (as read) = the correction.
2. Correction for standard + observed value of check sample (as read) = correct value of check sample.

Such corrected values were obtained for both the final and the initial melting temperatures of each determination run in the duplication of the previous experiment design. The results of this second

interlaboratory study and the ranges by laboratories for the various rubber chemicals are listed in Figs. 2 to 7.

The data were analyzed by the statistical method outlined in Table I. The estimates obtained from this analysis are shown in Table III as derived from the proper variance components indicated in Table II. Table III is a tabulation of 95 per cent confidence limits on the average of single determinations by each of two technicians in one laboratory.

Table III, section (*A*) provides an estimate of the ability of technicians in a laboratory to reproduce the average result obtained in that laboratory. Section (*B*) estimates what might be called the ability of any pair of technicians in one laboratory to reproduce the industry-wide average. Section (*C*) supplies a measure of the ability of a pair of technicians in each of two different laboratories to check each other.

Results of Second Study

The confidence limits for each of the three comparisons is given both with and without the use of a standard control chemical. In Table III section (*A*) it is found that in only six of twelve cases are the confidence limits improved by the use of a standard. In section (*B*) improvement is noted in nine of twelve, which is the case in section (*C*) also. In most cases where there is improvement it is slight. The results show that the between laboratory differences are still significant, indicating no detectable improvement from the use of standards. No evidence is found that the use of standards reduced the variations between technicians or between the determinations made on different days by the same technician. It is concluded that the use of a melting range control does not result in a general and significant increase of precision. The cost and effort of maintaining standard control samples does not appear justified.

Examination of the confidence limits given in Table III indicates that only in section (*A*) are the confidence limits reasonably narrow. These confidence limits are sufficiently narrow to warrant use of the average melting temperature as a criterion of purity or quality within a single laboratory. Implicit in this statement is the condition that all factors involved in the determination within the single laboratory be held constant. For example, equipment, apparatus settings, and location of equipment should not be changed, and a minimum number of technicians should do all determinations within the laboratory.

TABLE III.—PRECISION OF MELTING RANGE DETERMINATION.

95 per cent confidence limits on average of single determinations by each of two technicians in one laboratory.

	Average Melting Temperature			
	Initial		Final	
	No Standard	With Standard	No Standard	With Standard
(*A*) As compared to average of results run repeatedly by pairs of technicians in same laboratory.[a]				
Tetraethylthiuram disulfide	±0.2	±0.35	±0.2	±0.3
Phenyl-β-naphthylamine	±0.2	±0.3	±0.15	±0.2
Tetramethylthiuram disulfide	±1.3	±0.6	±1.0	±0.8
Mercaptobenzothiazole disulfide	±1.9	±0.4	±1.5	±0.8
Mercaptobenzothiazole	±1.2	±0.5	±0.1	±0.4
Zinc dimethyldithiocarbamate	±1.0	±0.5	±0.4	±0.4
(*B*) As compared to average of results run repeatedly by pairs of technicians in all laboratories participating.				
Tetraethylthiuram disulfide	±1.0	±1.3	±1.3	±1.2
Phenyl-β-naphthylamine	±1.5	±1.3	±1.1	±0.9
Tetramethylthiuram disulfide	±3.7	±3.1	±3.4	±3.1
Mercaptobenzothiazole disulfide	±4.3	±1.8	±4.5	±4.0
Mercaptobenzothiazole	±3.4	±4.0	±0.9	±1.2
Zinc dimethyldithiocarbamate	±3.6[b]	±2.4	±3.4[b]	±1.3
(*C*) As compared to the average of results run by any single pair of technicians in any single laboratory participating.				
Tetraethylthiuram disulfide	±1.4	±1.8	+1.8	±1.7
Phenyl-β-naphthylamine	±2.1	±1.8	±1.7	±1.3
Tetramethylthiuram disulfide	±5.2	±4.4	±4.8	±4.4
Mercaptobenzothiazole disulfide	±6.1	±2.5	±6.4	±5.7
Mercaptobenzothiazole	±4.8	±5.7	±1.3	±1.7
Zinc dimethyldithiocarbamate	±5.1	±3.4	±4.8	±1.8

[a] Estimated from $\sigma_e^2/2$. See Table I.
[b] Data of one laboratory omitted because they were outside the normal range of values obtained by all other laboratories.

Conclusion

The melting range procedure as described in this report is capable of providing melting range control within a single laboratory. Because of poor reproducibility of data between different laboratories, the melting range procedure is not recommended as a basis for absolute definition of quality.

Acknowledgment:

The statistical procedures followed in this study were reviewed by the statistical quality control personnel of several of the participating laboratories. The great majority of the statistical calculation and interpretation is the work of Hillman C. Harris and K. A. Chatto of E. I. du Pont de Nemours & Co., Inc. The members of the task group wish to express their gratitude and indebtedness for this work, which has made possible a true understanding of the significance of the data.

Automatic System for Spectrometric Data

(*Continued from page 91*)

On the punched cards that are used, each set of 4 successive columns represents a channel of information. Reading from the left, first is the sample identification code number (set manually) followed by 18 channels of measurements corresponding to 18 chemical elements; finally the last 4 columns record a serial number which is automatically advanced one digit for each run of the instrument.

Statistical results obtained from these data include (1) an analysis of variance for each of the 18 elements with respect to locations in the metal; (2) the standard deviation of the method; (3) a listing of variances that are significant with respect to the standard deviation; (4) the coefficient of variation, and (5) maximum, minimum, and median values for each chemical element measured.

The Bookshelf

A Treatise on Photoelasticity

E. G. Coker and L. N. G. Filon, revised by H. T. Jessop; Cambridge University Press, New York; 720 pp.; $12.50.

PHOTOELASTICITY as a method of exploring stress distributions in engineering structures dates from Coker's development of xylonite as a model material about 1909 and his subsequent extensive studies of theory and applications. Little use was made of photoelasticity by engineers until the 1930's, immediately following publication of the first edition of this book, which firmly established the theory, techniques, and methods for complete determination of stresses in models of two-dimensional form.

The original Coker and Filon treatise published in 1931 constituted a complete reference work to the basic theory of photoelasticity at that time. For many years it was used as the outstanding authority on the basic theory and methods and served as a comprehensive source book for research workers in the field. The first edition has been out of print for some years. In this new edition the text is substantially unchanged except for the correction of misprints and minor errors. Mr. Jessop has brought the book up to date by adding an introductory section surveying developments in techniques since 1931 and has added an extensive bibliography of important publications in the field since that time.

The developments in techniques in recent years have done nothing to impair the validity of the theory which forms the most important portion of the book covering the first few chapters. Some of the practical methods of instrumentation and techniques described have now been replaced by new and simplified procedures because of the availability of model materials having greater optical sensitivity. However, this does not invalidate the many examples of practical application to problems of engineering design which are found in the latter half of the book. Possibly some of the numerical results reflect slight inaccuracies of the early methods but the results and analyses are still useful today. The main value of the book remains that of serving as a treatise for the research worker or the engineer who wishes to obtain a thorough understanding of the basic theory and applications of photoelasticity. It covers the subject with greater depth and rigor than most other texts and therefore is not suitable for an initial approach to the subject by one not thoroughly versed in mathematics.

The book is divided into chapters as follows: I. general optical theory, II. elementary theory of elasticity, III. theory of artificial double-refraction, IV. certain problems in a plane involving straight and circular boundaries, V. flexure of beams, VI. holes and cracks, VII. the testing of materials, VIII. structures and machines.

Even those engineers not mathematically inclined or thoroughly familiar with photoelastic methods of analysis will find interesting many solutions of practical problems involving stresses in members with holes, notches, cracks, in chapters V and VI and the elastic stress distributions in many types of standardized test specimens in chapter VII together with stress distributions in wheels, joints, flanges, footings, etc. in chapter VIII.

The new introduction added by Mr. Jessop comprises a rather complete and concise summary of the principal developments in techniques and methods of analysis not covered in the original book. New procedures for separation of principal stresses, new materials for models, three-dimensional analysis with frozen stress or by the scattered light method, etc. are described and specific references made to original articles on each new development.

In general this book is well worth a quick review by the busy engineer interested in more precise methods of stress analysis and warrants a careful study by specialists in the field to review the many intricacies of basic theory so necessary to the satisfactory planning and interpretation of a photoelastic investigation.

T. J. DOLAN

Ceramic Fabrication Processes

Edited by W. D. Kingery; The Technology Press of the Massachusetts Institute of Technology and John Wiley & Sons, Inc., New York; 235 pp.; $9.50.

THE appearance of a new publication in the ceramics field is almost always an event worth noting and such is the case of "Ceramic Fabrication Processes." Although this text does not lend itself to undergraduate classroom use, students as well as plant and engineer chemists will find it a valuable source of the latest developments in principles and practices in the ceramic fabrication field. The book is based on a series of lectures given at a special summer session at MIT during the summer of 1956.

Essentially, the book is an up-to-date theoretical and practical series of dissertations on slip casting, pressure fabrication, plastic forming, and drying and firing practices. There are also discussions on the effect of microstructure on electrical and mechanical properties, particularly orientation, recrystallization, nucleation, and other facets of ceramic structures. Information is given in terms of the latest knowledge on the subject presented by experts in their fields and copiously illustrated. ASTM members will recognize a number of the Society members as contributors.

Radioisotopes, A New Tool for Industry

Sidney Jefferson; Philosophical Library Inc., 15 E. Fortieth St., New York 16, N. Y.; 106 pp.; $4.75.

THE AIM of this little book is to present to the layman some fundamentals of radioactivity and the manner in which radioisotopes may be applied in industry. Although the technical matter is considerably simplified, complete understanding may be beyond the average layman. For the industrial manager and men of general technical background, however, the author has provided a clear and simple presentation of some industrial applications of radioisotopes and their scientific basis.

One particularly refreshing aspect of this book is the straightforward manner in which the author has presented his thesis. There is none of the "atomic age wonders-of-the-future" type of writing which is generally found in books of this type. Instead, simple descriptions of radioisotope applications already accomplished are presented as a matter of fact. In this connection, too, the hazard of industrial use of radioisotopes is placed in its proper perspective as a relatively easily controlled industrial hazard.

To one trained in nuclear science, the extreme simplification of the presentation of the basic fundamentals of radioactivity appears regrettable. On the other hand, it should be appreciated that this book will probably stimulate the general technical man to consider possible applications of radioisotopes to the solution of his particular industrial problems.

M. POBEREskin

The Industrial pH Handbook

Compiled and edited by Thomas J. Kehoe, Beckman Instruments, Fullerton, Calif.; $2.

THIS 80-page manual covers the industrial application of Beckman equipment for pH measurement in manufacturing. It reviews process pH control systems, their principles, and application engineering and equipment. The book provides a convenient reference source on pH for persons involved in designing, engineering, purchasing, and operating industrial pH systems.

A systematic subject classification, plus alphabetical indexing makes for easy reference to the subjects covered. The handbook contains approximately 100 illustrations plus some charts and tables. Of considerable value is a bibliography of reference literature on pH measurement.

(Continued on page 124)

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Fausett, Robert J., engineering geologist, Edward Kraemer and Sons, General Contractors, Plain, Wis. For mail: Box 236, Plain, Wis.

Jennings, William H., raw material engineer, Western Electric Co., Inc., Dept. 7651, Hawthorne Station, Chicago 23, Ill.

Lindsay, J. Douglas, engineer of materials, Illinois Division of Highways, Springfield, Ill. For mail: 126 E. Ash St., Springfield, Ill.

Mahlie, Carl C., superintendent, Service Dept., Quality Control, Inland Steel Co., 30 W. Monore St., Chicago 3, Ill.

Nelson Clarence, metallurgical laboratory director, Republic Steel Corp., 11600 S. Burley Ave., Chicago 17, Ill.

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Olle, John V., metallurgist, Motor Castings Co., 1323 S. Sixty-fifth St., West Allis 14, Wis.

Parsons, R. William, engineer, Western Contracting Corp., 400 Benson Bldg., Sioux City, Iowa. For mail: 3121 Douglas, Sioux City 4, Iowa. [A]

Schleicher, Frank, program director, Inland Testing Laboratories, 6401 Oakton St., Morton Grove, Ill. For mail: 2136 N. Twenty-second St., Milwaukee 5, Wis.

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Verbeck, George J., manager, Applied Research Section, Portland Cement Assn., 33 W. Grand Ave., Chicago 10, Ill.

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Carlson, Wilbur A., testing engineer, Herron Testing Laboratories, Inc., 1360 W. Third St., Cleveland 13, Ohio. For mail: 19518 Cherrywood Lane, Warrensville Heights, Cleveland 28, Ohio.

Milliken, William U., general superintendent, Bowerston Shale Co., Bowerston, Ohio. [A]

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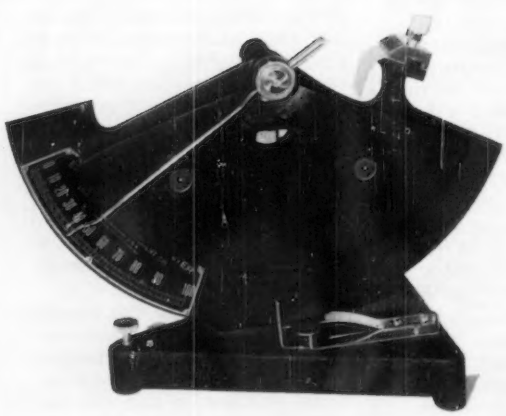
(*Continued on page 104*)

RIGHT IN STEP



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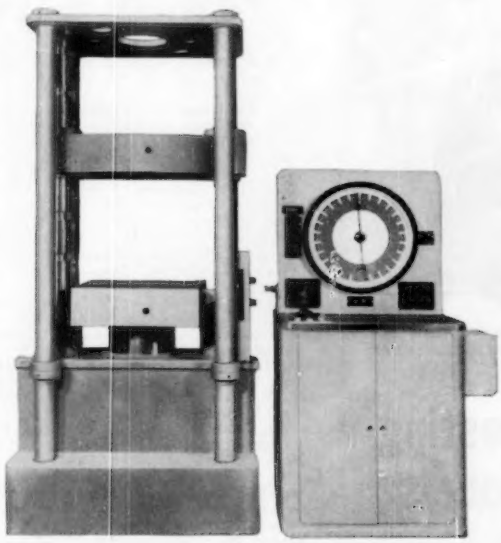

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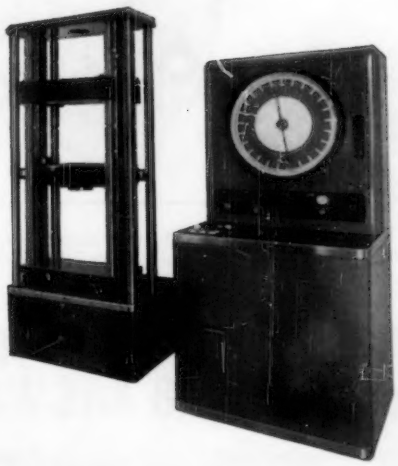

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Madara, Edw. J., president, Marvan Corporation, Box 219, West Hartford, Conn.
Markey, R. F., owner, Inspection Service, 80 Boylston St., Boston 16, Mass. For mail: 47 Wesley Rd., Framingham Centre, Mass.
McDonald, Matt J., Jr., P. F. McDonald and Co., 10 Powerhouse St., South Boston 27, Mass. For mail: 75 Brandlee Rd., Milton 86, Mass.
Page, Charles P., manager, Quality Control, General Electric Co., Circuit Protective Devices, Dept., Plainville, Conn.
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Duke, E. T., director, Product Development, Nicolet Industries, Inc., Nicolet Ave., Florham Park, N. J.
Engelhardt, George B., member of technical staff, Bell Telephone Laboratories, Inc., Murray Hill, N. J. For mail: 28 Clubway, Hartsdale, N. Y.
Fish, John J., technical director, Warwick Wax Co., 750 Third Ave., New York 17, N. Y. For mail: 4 E. Eighty-ninth St., New York 28, N. Y.
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Grotto, LeRoy A., executive engineer, Research, Mack Trucks, Inc., 1120 S. Second St., Plainfield, N. J.
Loomis, Kenyon, executive secretary, Adhesives Manufacturers Assn., 441 Lexington Ave., New York 17, N. Y.
Mitchell, H. I., director of quality control, White Laboratories, Inc., Kenilworth, N. J.
Pizzino, Michael A., materials engineer, New York Naval Shipyard, Material Laboratory, Code 955, Brooklyn, N. Y.
Raymond, Lloyd E., process engineer, The Singer Manufacturing Co., 915 Pembroke St., Bridgeport 8, Conn.
Roediger, Joseph C., research associate, Esso Research and Engineering Co., Box 121, Linden, N. J. For mail: 119 Jefferson Ave., Westfield, N. J.
Schiffman, Robert L., assistant professor of civil engineering, Dept. of Civil Engineering, Rensselaer Polytechnic Inst., Troy, N. Y.
Starr, Wendell T., dielectric chemist, General Engineering Lab., General Electric Co., Schenectady, N. Y.
Zeller, Andrew F., Sales Development Dept., Olin Mathieson Chemical Corp., 275 Winchester Ave., New Haven, Conn.

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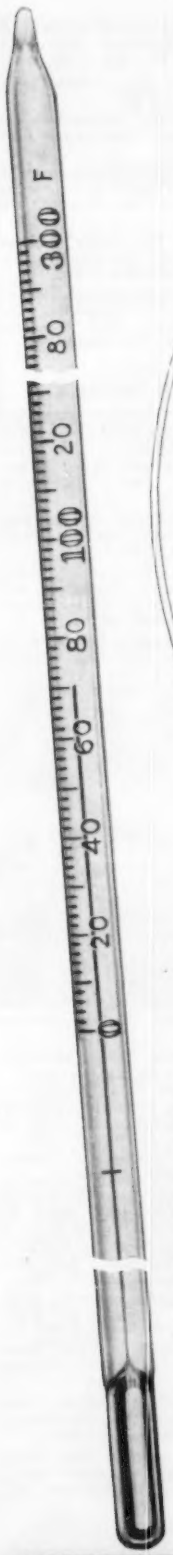
Brandt, Francis A., irradiations engineer, General Electric Co., Vallecitos Atomic Lab., Box 846, Pleasanton, Calif.
Fuller, Robert John, materials testing engineer, Department of Public Works, City Hall, Richmond, Calif. For mail: 100 Echo Ave., Oakland, Calif. [A]
Hall, Herbert R., Specification Dept., Wilsey & Ham, 111 Rollins Rd., Millbrae, Calif. Sacramento State College Library, 6000 J St., Sacramento 19, Calif.

(Continued on page 106)



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(*Continued from page 104*)

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Nolan, Joseph R., chemist, H. H. Robertson Co., Fourteenth St., Ambridge, Pa.

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Bare, Ben K., partner, Burgess & Niple, Engineers, 2015 W. Fifth Ave., Columbus 12, Ohio.

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Kuhlman, D. W., general superintendent, American Creosoting Corp., 112 S. Fifth St., Louisville 2, Ky.

Stanton, John F., project engineer, Materials Laboratory, WADC, Wright-Patterson Air Force Base, Ohio. For mail: 120 Westhaven Dr., Dayton 29, Ohio.

Waspe, Marvin E., assistant plant manager, Bendix Aviation Corp., 3130 Wasson Rd., Cincinnati 8, Ohio. [A]

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Bleil, Raymond G., manager, Industrial Maintenance Div., Metalweld, Inc., 2617 Hunting Park Ave., Philadelphia 29, Pa.

Compton, Alfred N., Jr., research chemist, E. F. Houghton and Co., 303 W. Lehigh Ave., Philadelphia 33, Pa. For mail: 2009-B S. S. John Russell Circle, Elkins Park 17, Pa.

French, Josiah, head, Mechanical Testing Section, Gulf Oil Corp., Refinery Technology Lab., Box 7409, Philadelphia 1, Pa.

Karrer, Max R., vice-president and plant manager, Electric Hose and Rubber Co., Twelfth and Dure, Wilmington 99, Del.

Kent, Arthur B., chief chemist, Sun Oil Co., Marcus Hook, Pa.

Martin, Sydney A., partner, Richardson, Gordon and Associates, 3 Penn Center Plaza, Philadelphia 2, Pa.

Rasmussen, Hakon, chief structural engineer, G. M. Ewing Co., 17th Fl., Western Savings Bldg., Broad and Chestnut Sts., Philadelphia 7, Pa.

Thompson, Warren R., power engineer, United Engineers and Constructors, Inc., 1401 Arch St., Philadelphia 5, Pa.

Woodring, Philip W., soils engineer, Gannett, Fleming, Corddry & Carpenter, Inc., Box 366, Harrisburg, Pa. For mail: 3805 Bonnyview Rd., Harrisburg, Pa.

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Giove, John L., chief metallurgist, Homestead Works, U. S. Steel Corp., Homestead, Pa.

Herbst, George E., Metallurgical Dept., McConway & Torley Corp., 109 Forty-eight St., Pittsburgh 6, Pa.

Jemian, Wartan A., senior fellow, Mellon Institute of Industrial Research, 4400 Fifth Ave., Pittsburgh 13, Pa. For mail: R.D. 4, Box 620, Greensburg, Pa.

Pittman, Charles U., technical director, Industrial Pitch, Koppers Co., Inc., 15 Plum St., Verona, Pa.

Semans, G. R., director of research and technology, Jessop Steel Co., Green St., Washington, Pa. For mail: 54 Kimber Dr., Bridgeville, Pa.

Shields, Bruce M., chief metallurgist, Duquesne Works, U. S. Steel Corp., Duquesne, Pa.

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Frazer, W. O., plant manager, Nixdorff-Krein Manufacturing Co., 916 Howard St., St. Louis 6, Mo.

Lee, R. P., director, Technical Research, Consumers Cooperative Assn., Box 7305, Kansas City 16, Mo.

Sherwood, Walter D., manager, Power Plant Research, Trans World Airlines, 10 Richards Rd., Kansas City, Mo. For mail: 1267 W. Seventy-first Terrace, Kansas City 14, Mo.

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DuBose, Lawrence A., associate professor, Civil Engineering Dept., University of Alabama, Box 1214, University, Ala.

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Kononoff, Alexis B., senior partner, Alexis B. Kononoff, Consulting Engineers, 620 N. W. Thirty-second St., Miami 37, Fla.

Miami, City of, Building Dept., Jimmy Echols, engineer, Building Div., Box 708, Coconut Grove Station, Miami 33, Fla.

Renwick, W. H., industrial engineer, J. P. Stevens and Co., Inc., Appleton and Whitmire Plants, Box 350, Anderson, S. C.

Schmut, Rudolf, research chemist, West Virginia Pulp and Paper Co., Charleston, S.C. [A]

Smith, Burton D., sales manager, Southern Cen-Vi-Ro Pipe Corp., Box 1205, Mobile, Ala.

Wright, Ray E., design engineer, Kett Technical Center, Box 2021, Pompano Beach, Fla. For mail: 95 S. E. Fifteenth St., Deerfield Beach, Fla. [A]

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(*Continued on page 108*)

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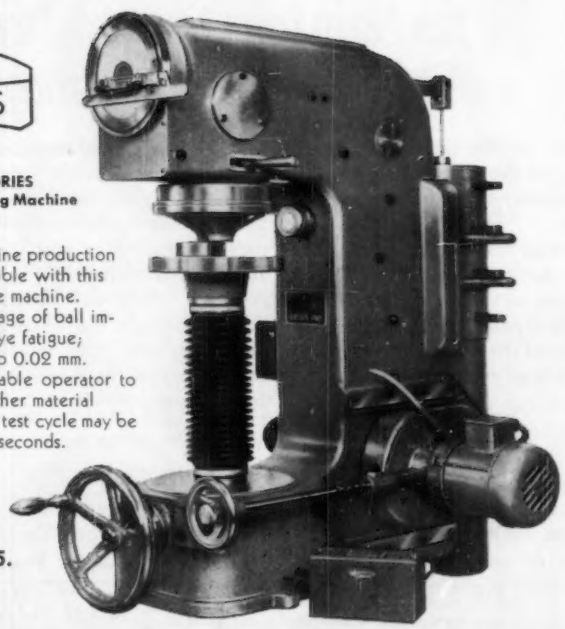

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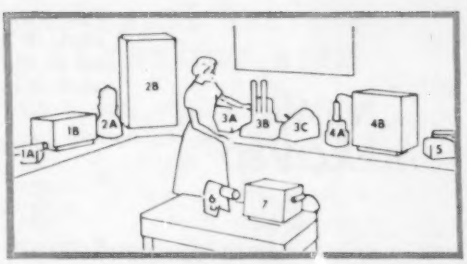
2A Model DS5-5 Scintillation Well Counter with exclusive "scaler-spectrometer" circuit and **2B** Model 1820 Recording Spectrometer for automatic quantitative energy separation of gamma-ray spectra.

3A Model 183B Count-O-Matic Binary Scaler, **3B** Model C110B Automatic Sample Changer with Model D47 Gas Flow Counter, and **3C** Model C111B Printing Timer for completely automatic changing, counting, and recording of as many as 35 soft beta emitting radioactive samples.



4A Model 3054 Manual Sample Changer with Model DS5 Scintillation Detector which features interchangeable alpha, beta, or gamma sensitive crystals connected to Nuclear-Chicago's finest scaler, the **4B** Model 192A Ultrascaler. Model 192A features decade scale of 10,000, one millivolt sensitivity, and precision automatic circuitry.

5 Model 2612P Portable Survey Meter contains a 1.4 mg/cm² thin window G-M tube for surveying for alpha, beta, or gamma contamination up to 20 milliroentgens per hour.

6 Model 2586 "Cutie Pie" features interchangeable ionization chambers for measuring beta, gamma, or x-radiation up to 250 roentgens per hour.

7 Model 1620A-S Analytical Count Rate Meter offers a wide choice of full scale ranges, four time constants, wide range high voltage supply. It is shown with a Model D34 thin window G-M tube and P11 probe for continuous monitoring or analytical radioactivity determinations.

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(*Continued from page 106*)

Kerner, Charles A., chief engineer, Northrop Aircraft, Inc., Anaheim Div., 500 E. Orangethorpe Ave., Anaheim, Calif.
Price, Stanford O., manager, Steel Div., The R. J. M. Co., Box 3848, Terminal Annex, Los Angeles 54, Calif.
Romig, John R., chief chemist and chemical engineer, California Portland Cement Co., Colton, Calif.
Seymour, Raymond B., president, Loven Chemical Company of California, 23874 Pine St., Newhall, Calif.

SOUTHWEST DISTRICT

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Fuller, J. D., assistant chief chemist, Cities Service Refining Corp., Lake Charles, La.
Lemmons, Robert T., chief chemist, Celanese Corporation of America, Box 937, Pampa, Tex.
Nelson, Waldemar S., president, Bedell & Nelson Engineers, Inc., 1200 St. Charles Ave., New Orleans 13, La.
Rosenbalm, Mary Ada, Quality Control, Keystone Valve Corp., 5325 Kirby Dr., Houston 5, Tex. For mail: Box 6716, Houston 5, Tex.
Texas Technological College, Library, Periodicals Dept., Lubbock, Tex.
Uhrmacher, Ralph R., president, Research and Development Associates, Inc., 909 N. Main St., Ft. Worth Tex.

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Virginia Lightweight Aggregate Corp., Beverly K. Powers, manager, Box 780, Roanoke, Va.
Bounous, Edwin P., chief engineer and director of research, Drexel Furniture Co., Morganton, N. C.
Cornwell, Eugene W., advisory engineer, Film Div., American Viscose Corp., Fredericksburg, Va. For mail: 906 Sylvania Ave., Fredericksburg, Va.
Freedman, Stanley P., plant manager, Maryland Cup Co., 1200 S. Eutaw St., Baltimore 30, Md.
Getz, Melvin E., chemist, U. S. Bureau of Mines, College Park, Md. [A]
Gray, A. N., development engineer, Western Electric Co., Inc., 2500 Broening Highway, Baltimore 24, Md. For mail: Edgewood, Md.
Jarrett, William T., Airframe and Equipment Branch, Structures and Design Elements Group, Civil Aeronautics Administration, Washington 25, D. C. For mail: 7506 Inzer St., Springfield, Va.
Kilduff, Timothy J., chemist, Diamond Ordinance Fuze Labs., U. S. Department of the Army, Connecticut Ave., and Van Ness St., N. W., Washington, D. C. For mail: 329 Rhode Island Ave., N. E., Washington 2, D. C.
Powers, D. A., superintendent of quality control, Celanese Corporation of America, Box 444, Cumberland, Md.
rice, Howard L., Jr., aeronautical research engineer, National Advisory Committee for Aeronautics, Langley Field, Va. For mail: Apt. 1, 429 Prince George St., Williamsburg, Va. [A]
U. S. Department of the Army, Quartermaster Research and Engineering Field Evaluation Agency, Howard W. Hembree, scientific director, Fort Lee, Va.

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Harrison Radiator Div., General Motors Corp., D. S. Maxwell, staff engineer, Lockport, N. Y.
Cowles, Gordon B., senior metallurgist, Eastman Kodak Co., Apparatus and Optical Div., 400 N. Plymouth Ave., Rochester 4, N. Y.
Holman, Alan T., plant metallurgist, Morse Chain Co., S. Aurora St., Ithaca, N. Y.
Hopton, Alfred W., owner, Niagara Industrial Laboratories, Maple Ave. and Nineteenth St., Niagara Falls, N. Y.
Mac Laren, J. W., associate, J. F. MacLaren Associates, 321 Bloor St., E., Toronto 8, Ont., Canada.

OUTSIDE ESTABLISHED DISTRICTS

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Clayson, G. S., president, William Ainsworth and Sons, Inc., 2151 Lawrence St., Denver 5, Colo.
Drus, Karl J., professor of engineering materials, University of Portland, Portland, Ore. For mail: 10921 S. W. Lancaster Rd., Portland 19, Ore.
Gardner, James R., inspector, Iron Fireman Manufacturing Co., 4784 S. E. Seventeenth, Portland, Ore. For mail: 217 N. E. 168th, Portland 30, Ore. [A]
Hereim, Andrew T., chief, Engineering Test Branch, Technical Operations, TD&A, Dugway Proving Ground, Dugway, Utah. For mail: 272 Highland Dr., Tooele, Utah.
Isbell, H. B., assistant treasurer, Isbell Construction Co., S. Virginia St. at Airport Rd., Reno, Nev. For mail: Box 2351, Reno, Nev.
Johnson, Walter H., field engineer, Holmes & Narver, Inc., 828 S. Figueroa St., Los Angeles, Calif. For mail: 1105 Tamerack, Las Vegas, Nev.
Snodgrass, James D., associate chief, Physical Research, Oregon Forest Products Research Center, Box 571, Corvallis, Ore.
Walker, Leland J., president, Northern Testing Laboratory, Box 2091, Great Falls, Mont.

(*Continued on page 109*)

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Nightingale Supply Co., Ltd., The, Alan B. Moran, Joint Managing director, 4 Allen St., Waterloo, N.S.W., Australia.

Western Wire and Cable Co., Ltd., H. Kelsey, engineer, 2015 Columbia St., Vancouver 10, B.C., Canada.

Audy, René, soils engineer, Cartier Côté & Piette, 366 Lafleur Blvd., Ville La Salle, P.Q., Canada.

Decarie, Alex., chief engineer and vice-president, Pressure Pipe Co. of Canada, Ltd., 6905 Clamramald Ave., Montreal, P. Q., Canada.

Essex College, Assumption University, Tze Sun Wu, associate professor, Engineering Dept., Windsor, Ont., Canada.

Fujikubo, Sanshiro, director and manager, Hitachi Works, Hitachi, Ltd., Hitachi, Ibaraki, Japan.

Harvey, Barton, original equipment engineer, Paton's Brake Replacement Pty., Ltd., 264 E. Boundary Rd., E. Bentleigh, Melbourne, Australia.

Hubert, Georges, 98 Avenue de la Paix, Marcinele, Belgium.

Hunnicutt, Horace A., foreign technical representative, The International Nickel Co., Inc., New York, N. Y. For mail: Caixa Postal 6980, São Paulo, Brazil.

Imai, Tetsuichi, chief technician, The Industrial Promotion Assn., Tokyo Institute of Technology, 1 Ookayama, Meguro-ku, Tokyo, Japan. For mail: 72 Nagayato-cho, Shibuya-ku, Tokyo, Japan.

Jones, Barney T., president, Barney T. Jones, Inc., Umeda Bldg., Umeda, Osaka, Japan. For mail: Central P.O. Box 290, Osaka, Japan.

Lapinas, R. A., assistant concrete engineer, Mount Royal Paving and Supplies, Ltd., Box 2000, Montreal 36, P.Q., Canada. [A]

National College of Rubber Technology, E. R. Yescombe, librarian, Northern Polytechnic Library, Holloway Rd., London N. 7., England.

Stuhlmann, Walter, quality manager, International Business Machines Corp., Böblinger Allee 49, Sindelfingen, Württ, Germany.

Swedenborg, Håkan, managing director, Tekniska Röntgencentralen AB, Stockholm 51, Sweden.

Tamura, Yasushi, lecturer, Waseda University, Shinjiku-ku, Tokyo, Japan. For mail: 9 Azabumikawadai, Minato-ku, Tokyo, Japan.

Torres Herrera, Francisco, technical director, Cociel Constructura Civil, y Electrica S. A., Av. Chapultepec 384, 6° Piso, Mexico 7, D. F., Mexico.

OTHER SOCIETIES EVENTS

July 28–August 1—**Technical Association of the Pulp and Paper Industry,** 13th Engineering Conference, Multnomah Hotel, Portland, Oregon.

August 11–14—**Society of Automotive Engineers,** National West Coast Meeting, Ambassador Hotel, Los Angeles, Calif.

August 17–22—**Illuminating Engineering Society,** National Technical Conference, Royal York Hotel, Toronto, Canada.

August 18–23—**International Conference on Semiconductors,** Rochester, N. Y.

August 19–22—**American Institute of Electrical Engineers,** Pacific General Meeting, Sacramento, Calif.

August 25—**Gordon Research Conference on Adhesion,** New Hampton School, New Hampton, N. H.

September 7–12—**American Chemical Society,** 134th National Meeting, Chicago, Ill.

September 8–10—**American Institute of Electrical Engineers,** 1958 Conference on Electrical Insulation, Cleveland, Ohio.

September 8–13—**Institute of the Aeronautical Sciences,** 1st International Congress of the International Council of the Aeronautical Sciences, Palace Hotel, Madrid, Spain.

September 15–17—**Canadian Association for Applied Spectroscopy,** 5th Ottawa Symposium on Applied Spectroscopy, Ottawa Ont.

September 15–19—**Instrument Society of America,** Conference and Exhibit, Convention Hall, Philadelphia, Pa.

September 17–21—**National Sand and Gravel Assn.** and **National Ready Mixed Concrete Assn.,** Semi-Annual Meeting, Sun Valley Lodge, Sun Valley, Idaho.

September 22–25—**American Mining Congress,** Metal Mining & Industrial Minerals Convention and Exposition, Civic Auditorium, San Francisco, Calif.

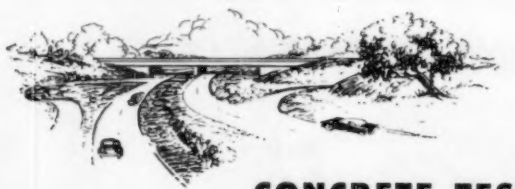
September 23–26—**Association of Iron and Steel Engineers,** Annual Convention and Iron and Steel Exposition, Cleveland Public Auditorium, Cleveland, Ohio.

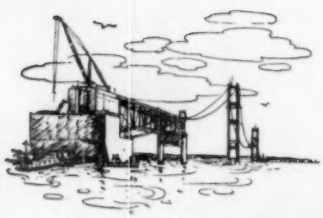
September 25–27—**Porcelain Enamel Institute,** Annual Meeting, The Greenbrier, White Sulphur Springs, W. Va.

September 28–October 1—**American Society of Mechanical Engineers,** Power Conference, Statler Hotel, Boston, Mass.

September 28–October 2—**The Electrochemical Society,** Chateau Laurier, Ottawa, Canada.

September 29–October 3—**American Society of Tool Engineers,** Western Tool Show and Semi-Annual Meeting, Shrine Exposition Hall, Los Angeles, Calif.





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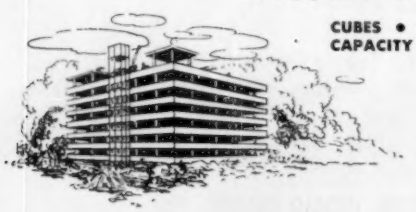

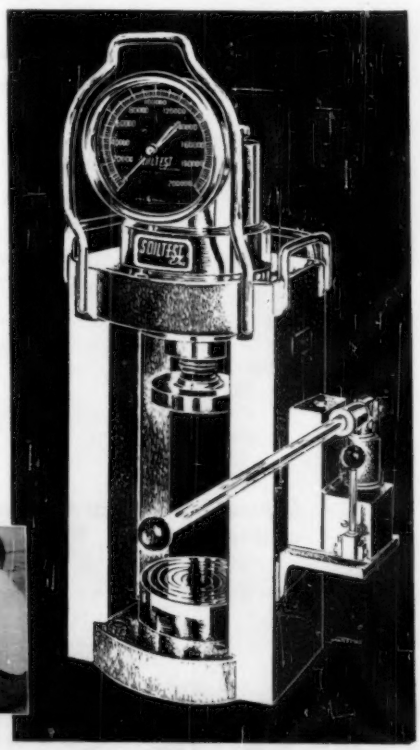

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FOR FURTHER INFORMATION CIRCLE 956 ON READER SERVICE CARD

PERSONALS...

News items concerning the activities of our members will be welcomed for inclusion in this column

Julius Adler, consulting engineer, Philadelphia, Pa., has been made an honorary member of Committee D-4 on Road and Paving Materials, in recognition of valued contributions over a period of many years. He is a past chairman of the committee. He also has been active in Committee C-9 on Concrete and Concrete Aggregates, representing the American Public Works Assn. in both committees.

Herschel H. Allen, partner, J. E. Greiner Co., Baltimore, Md., has been elected to the presidency of the American Institute of Consulting Engineers.

Ross P. Anderson, for many years technologist for the American Petroleum Institute, New York City, and secretary of its Division of Refining, was among a number of American Chemical Society members recently honored on completion of 50 years of ACS membership. Mr. Anderson is an honorary member of ASTM Committee D-2 on Petroleum Products and Lubricants, having served as secretary of this main committee from 1925 to 1945. He served as an ASTM Director from 1942 to 1944.

M. Th. Antoniades, formerly development chemist, Roxalin Co. of Canada, Ltd., New Toronto, is now with the Canadian National Defence, Inspection Branch, Ottawa, his activities concentrated on infrared spectrophotometric analyses.

R. Barney Barnhill, until recently materials specifications engineer, The Bechtel Corp., Los Angeles, Calif., has established offices as consulting engineer, Barnco Engineering Service Co., Tulsa, Okla.

O. A. Battista, science writer and head of an analytical group at American Viscose Corp., Marcus Hook, Pa., has been given the second annual Mary Award, sponsored by the Mary Guild, a Catholic organization. The award recognized his efforts to explain science on a popular level while emphasizing the divine origin of nature. He is author of "God's World and You" and "How to Enjoy Work and Get More Fun Out of Life." In ASTM, Dr. Battista is vice-chairman of Committee D-23 on Cellulose and Cellulose Derivatives.

Howard S. Bean, chief of the Capacity, Density, and Fluid Meters Section, National Bureau of Standards, Washington, D.C., has been awarded the U. S. Department of Commerce Gold Medal for Exceptional Service. The Award cited his distinguished service to mechanical engineering for over 35 years through the development of codes for the metering of fluids and through contributions to the technical literature in this field. Mr. Bean has served for many years on ASTM Committee D-3 on Gaseous Fuels.

Past-President **Leslie C. Beard, Jr.,** recently retired (taking advantage of early retirement plans) as coordinator of research, Socony Mobil Laboratory, Socony Mobil Oil Co., New York City, where he had worked for many years as assistant director of the Research Laboratories. He is now making his home at his farm in Southern Pennsylvania, in Waynesboro near the Pennsylvania-Maryland line. On June 30 many of his company associates and friends including ASTM members and committee members honored him at a testimonial dinner at Forest Hills Inn, Long Island, N. Y.

(*Continued on page 112*)

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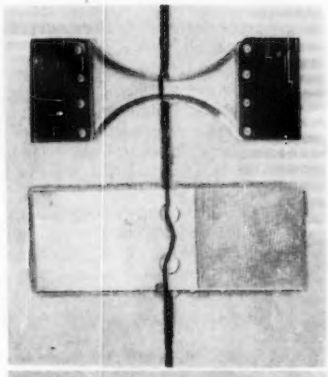

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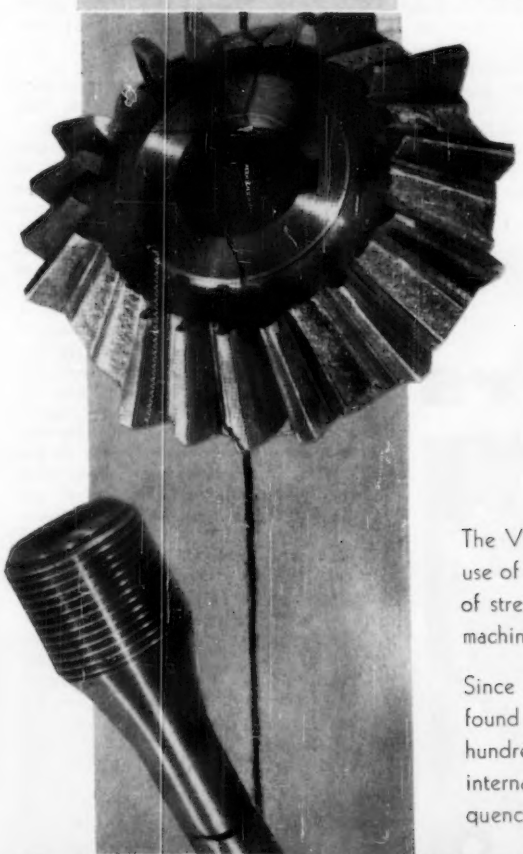

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CIRCLE 958 ON READER SERVICE CARD

(*Continued from page 110*)

John M. Bierer has retired as president of Woven Hose and Rubber Co., Cambridge, Mass. He continues as a director and vice-president of the American Biltrite Rubber Co. Mr. Bierer has been active for many years in ASTM Committee D-11 on Rubber and Rubber-Like Materials, and currently is serving on the New England District Council.

Maurice H. Bigelow has been appointed vice-president of Barrett Div., Allied Chemical Corp., New York City. Formerly technical director, he will continue to head Barrett's Research and Development Department. Dr. Bigelow has been active for many years in a number of ASTM technical committees.

Joseph A. Blecki, materials engineer for the planning and project engineering department of The Detroit Edison Co., Detroit, Mich., retired June 1 after more than 37 years of service with the company. Mr. Blecki had been a member of Committee A-1 on Steel and its subcommittees concerned with steel tubing, pipe, valves, fittings, and pipings and flanges for high-temperature and subatmospheric temperatures. He is succeeded in his company by **I. Arthur Rohrig** who also succeeds Mr. Blecki in the membership on Committee A-1.

William Blum, retired chief, Electrodeposition Section and Assistant Chief, Chemistry Division, National Bureau of Standards, Washington, D. C., has been chosen as winner of the first annual "Scientific Achievement Award" of the American Electroplaters Society. In ASTM he has been very active in Committee B-8 on Electrodeposited Metallic Coatings, receiving an ASTM Award of Merit in 1951 for valued contributions to the work of this committee.

Walter Bonsack is now on the staff of Aluminum and Magnesium, Inc., Sandusky, Ohio, as chief metallurgist.

William Brammer is now sales manager of Pressure Castings, Inc., Cleveland, Ohio. He was formerly associated with the Light Metals Div., Thompson Products, Inc.

Wallace R. Brode, who is serving as science adviser to the Department of State, has been awarded the U. S. Department of Commerce Gold Medal for Exceptional Service. It was given in recognition of his international leadership in the physical sciences, including major contributions to the science of chemical spectroscopy and for highly distinguished authorship and editorship in this and other fields of science.

John E. Conrad, until recently with Collins & Aikman Corp., Cavel, N. C., is now superintendent, Rosemary Finishing Plant, J. P. Stevens and Co., Inc., Roanoke Rapids, N. C.

George H. Daigle has accepted a position on the engineering staff of Rocket Valve Corp., Denver, Colo. He had been with W. S. Rockwell Co., Fairfield, Conn.

F. N. Darmara, vice-president, Utica Drop Forge and Tool Div., Kelsey-Hayes Wheel Co., Utica, N. Y., has been named to the subcommittee on power plant materials of the National Advisory Committee for Aeronautics.

Kenneth W. Donle, manager of product engineering, Tube Reducing Corp., Passaic, N. J., has been appointed chief engineer.

C. H. Ellison, Jr. has been made executive vice-president, Southern Cement Co., Div. American-Marietta Co., Birmingham, Ala. Until recently he had been vice-president in charge of sales.

James H. Foote, chief engineer and president of Commonwealth Associates, Inc., Jackson, Mich., received an honorary Doctor of Science in Engineering degree from Wayne State University, Detroit, at its graduation ceremonies, June 12, at the State Fair Coliseum. Dr. Foote was cited as "as master of technical process and electrical power administration who has earned the respect and admiration of his professional colleagues. . . and a citizen of lively conscience who merits the warm appreciation of a grateful community." In ASTM Dr. Foote has been active in a number of the technical committees, especially Committee B-1 on Wires for Electrical Conductors, where he served as chairman 12 years, and secretary for four years. He has served two terms on the Board of Directors of the Society, and currently is serving as chairman of the Administrative Committee on Standards.

Thomas G. Foulkes, metallurgical engineer, Bethlehem Steel Co., Bethlehem, Pa., received the 1958 Bradley Stoughton Award of the Lehigh Valley Chapter of the American Society for Metals, for outstanding contributions to metallurgy. Mr. Foulkes is a member of ASTM Committee A-1 on Steel, serving as chairman of a subcommittee organized to study factors contributing to the brittle fracture of steels. **Bradley Stoughton,** professor emeritus, Lehigh University, is an ASTM member of 56 years' standing. ASTM member **Bernard R. Queneau,** assistant manager, Metallurgy, Inspection and Research, Tennessee Coal and Iron Div., United States Steel Corp., Fairfield, Ala., presented a talk on "Embrittlement of Metals" at the Stoughton Award Night Meeting.

Ezra Garforth, Jr. has been elected vice-president of sales, Steel Mill Div., Philadelphia Steel & Wire Corp., Philadelphia, Pa.

Harry Gordon, formerly general manager, Ideal Rubber Products Co., Brooklyn,

(*Continued on page 118*)

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Makes full use of the new Visicorder Principle. Records directly on paper which requires no powder magazines, liquids, vapors, or other processing. Daylight loading. Recording is accomplished in full view of the operator. Records are immediately visible and usable.

NUMBER OF CHANNELS
12, 24, or 36 active channels, as desired. Three magnet assemblies, each of which holds up to twelve ⅛″ Series M Honeywell galvanometers, plus two reference traces.

RECORDING WIDTH
12″ Visicorder paper (11⅜″ for active recording; ⅜″ margin for record numbering and event marking).

TRACE IDENTIFICATION
45° slope, interrupting galvanometer traces in sequence.

RECORDING SPEEDS
0.1 to 160 in./sec. Five speeds in each of 3 ranges (15 steps) via push-button control. No manual change of gears is required.

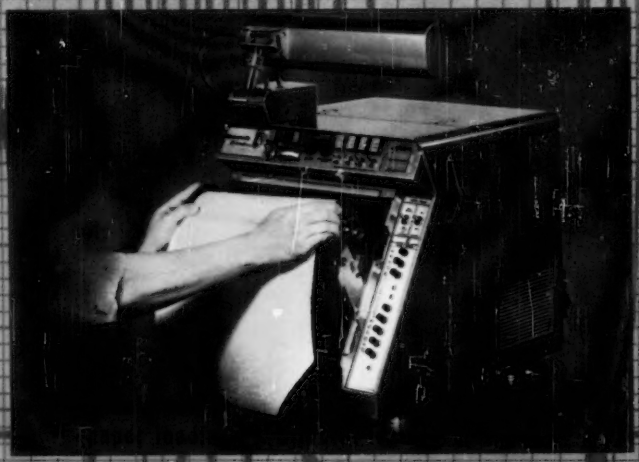
TIME LINES
Flash tube system. Choice of 5 intervals (.001, 0.01, 0.10, 1.00, 10.0 second) with each 10th line heavier. May be turned "off" or synchronized with external signals. With optical parallax being held to a minimum and negligible delay in initiating flash tube, timing lines and other data are recorded in exact time relationship.

RECORDING INTENSITY CONTROL
Proper aperture automatically established with record speed selection, or manually controlled as desired.

"NO RECORD" INDICATOR
Red indicator lamp and automatic shut-down of drive system indicates "No Record" if operator fails to turn on all necessary switches, if lamp fails, or if recording paper supply is exhausted. A separate lamp indicates when less than 25 feet of paper remains in supply.

PAPER LOADING
Simply done in a matter of seconds even by untrained personnel. All paper transport and take-up functions are integral. No separate magazines or other units required.

OTHER FEATURES
Automatic record length, adjustable 0-25′ (forward or reverse). Unused paper indicator. Paper knife. Push-button jump speed control. Record numbering system with provision for external actuation. Integral fluorescent light latensifier. Rack, table, or shock mounting. Provision for remote and/or multiplexed operation.



Time lines (every 10th line accented)

Trace identification

Longitudinal grid lines (every 5th line accented)

10-249 9 3 7 ← Record numbering

a representative record produced by the Model 1012 Visicorder. Note clear, accurate longitudinal grid lines, time lines, dynamic traces, and 45° sequential interruption of galvanometer traces for easy identification.

NEW MODELS OF THE *906* VISICORDER

The original 8-channel Model 906 Visicorder was the first successful oscillograph to break the barriers of frequency response and writing speed, and produce immediately readable records out to 2000 cps without the intervening steps of chemical processing.

Now the new Model 906A provides higher recording frequencies (DC to 3000 cps) and up to 14 channels of data. Factory-installed optional features and a wide variety of accessories are available as described at right. This means that you can select an instrument suited precisely to your requirements without price penalty for built-in or "special" features that may not be required.

The 906A Visicorder is provided in two models:

Model 906A-1 The basic instrument with high-sensitivity miniature plug-in galvanometers and magnet assembly. The use of subminiature galvanometers permits 14 simultaneous channels of data to be directly recorded at frequencies from DC to 3000 cps. These galvanometers are interchangeable in Honeywell-Heiland Model 906A-1, 708C, 712C, and 1012 oscillographs.

Model 906A-2 The basic instrument with "solid-frame" galvanometers and magnet bank from the original Model 906 Visicorder, providing for 8 channels of data to be directly recorded at frequencies from DC to 2000 cps. Galvanometers interchangeable in Model 906 Visicorder.

Reference Data: Write for Visicorder Bulletin

Minneapolis-Honeywell Regulator Co., Industrial Products Group, Heiland Division
5200 E. Evans Ave., Denver 22, Colo.

Honeywell

Heiland Division

Factory-installed optional equipment for both models includes:

Reducing collector lens to reduce static trace width to a minimum and concentrate maximum light source energy on galvanometers for normal writing speeds.

Standard collector lens to concentrate maximum light source energy on galvanometers for high writing speeds.

Recording intensity control to reduce spot intensity and record-trace breadth at low record travel and writing speeds.

Trace identification of the light-beam interruptor type for positive trace identification.

Grid line system—this exclusive feature provides longitudinal reference lines recorded simultaneously with data traces.

Timing unit provides timing pulses on .01, 0.1, or 1.0 second intervals.

Additional accessories for both models include:

Timing galvanometer provides maximum-density time lines (906A-1 only).

Record drive systems—your choice of 5 interchangeable systems, each covering 4 speeds.

Collector lenses (standard or reducing), recording intensity control, trace identifier, grid-line system (see above).

Relay rack adapters, bracket or gusset type.

Record takeup and latensifier to respool record paper after latensifying.

Record takeup unit to respool record paper.

USES OF THE VISICORDER

- *In control* for continually monitoring and recording reference and error signals.
- *In nuclear applications* to monitor and record temperatures, pressures, and other phenomena.
- *In production test* to provide a final dynamic inspection of electrical and mechanical devices.
- *In computing* to provide immediately-readable analog recordings.
- *In pilot and component testing* to accomplish more rapid evaluation of design and prototypes.
- *In medical applications* for dynamic blood pressures, electrocardiograms, and other physiological measurements.
- *In all test applications* which involve the assembly of considerable equipment and the gathering of personnel, the immediate Visicorder record will prove the success of the test at once before the test equipment is dispersed.

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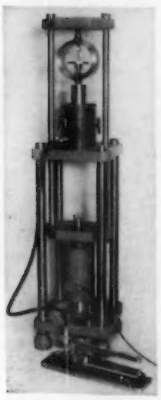

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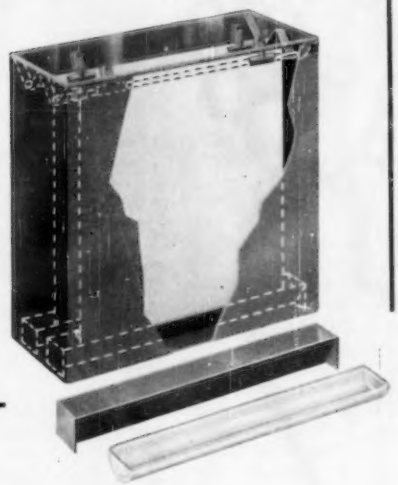
A new corrosion-resistant unit for ascending technique with 8 x 8-inch paper....



Thomas — Mitchell CHROMATOGRAPHY TANK

A simple, compact unit, designed for the development of two paper chromatograms 8 inches square, by one-dimensional or two-dimensional ascending techniques, using micro quantities (1 microliter portions) of test solution. See "Ascending Paper Chromatography: A Way To Do It," *Journal of the Association of Official Agricultural Chemists, Vol. 40, No. 4 (November, 1957) pp. 999-1029*, by Lloyd C. Mitchell, U. S. Division of Food, Food and Drug Administration.

Tank is approximately 9 inches long × 3½ inches wide × 9 inches deep, of Stainless steel; easy to clean; its small size relative to the paper area speeds achievement of vapor equilibrium.

In use, paper sheets are attached by means of Stainless steel spring clips to rods of either Stainless steel or glass, 8⅞ inches long × 3 mm diameter, which rest on removable, W-shape supports at top of tank. Lower edge of paper sheets is suspended in removable troughs which, in use, are filled with the mobile solvent. The V-shape Stainless steel troughs, 85 ml capacity, are 8¾ inches long × 1 inch wide × 1⅛ inches deep; borosilicate glass troughs, 75 ml capacity, have round bottom and are 8¾ inches long × 1 5/16 inches wide × 9/16-inch deep. A flat glass cover, with ground edges, permits observation of the ascending solvent front.

3677. Chromatography Tank, Stainless Steel, Thomas-Mitchell, as above described, with two supports for rods, glass cover, two each Stainless steel troughs and rods, four Spring Clips, 100 paper sheets, 8 × 8 inches..... **31.20**
Each, in lots of 6..... **28.25**
3677-B. Ditto, but with glass rods and troughs..... **29.50**
Each, in lots of 6..... **26.69**
3678-L. Paper Sheets, Whatman No. 1, size 8 × 8 inches. **Per 100** **1.70**

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FOR FURTHER INFORMATION CIRCLE 962 ON READER SERVICE CARD

(*Continued from page 112*)

N. Y., is now chief chemist, The Bond Rubber Corp., Derby, Conn.

E. J. Grajeck has accepted a position as technical service manager, Minnesota Mining & Mfg. Co., Bristol, Pa. He was formerly research chemist with Althouse Chemical Co., Div. of Crompton & Knowles Corp., Reading, Pa.

Arthur W. F. Green recently retired as chief metallurgist, Allison Div., General Motors Corp., Indianapolis, Ind. He resides at 7 Maywood Lane, Menlo Park, Calif. Mr. Green has been serving on several Panels of the Joint ASTM-ASME Committee on Effect of Temperature on the Properties of Metals, and on Committees D-11 on Rubber and E-7 on Nondestructive Testing.

John L. Hague, National Bureau of Standards, Washington, D. C., was the recipient of a Meritorious Service Award from the U. S. Department of Commerce. Mr. Hague has served on ASTM Committee E-3 on Chemical Analysis of Metals since 1949. Currently is a vice-chairman of this main committee, and is chairman of its Editorial Subcommittee.

Walter J. Hamburger, director of Fabric Research Laboratories, Inc., Dedham, Mass., has been elected a vice-president of The Textile Institute (Manchester, England). He is the first American to hold office in the Institute. Dr. Hamburger has served for many years on ASTM Committee D-13 on Textile Materials.

W. D. Hedges, chemical superintendent, Columbus Coated Fabrics Corp., Columbus, Ohio, has been elected vice-president of research and development.

Kenneth E. Holt, control director, Archer-Daniels-Midland Co., Minneapolis, Minn., received a prize from the American Oil Chemists' Society for his participation in the Smalley collaborative check sample series on drying oils series. Mr. Holt is active in ASTM Committee D-1 on Paint, Varnish, Lacquer, and Related Products, and is chairman of the Joint ASTM-AOCS Committee on Fatty Acids.

T. H. Hopper, chief, Industrial Crops Laboratory, Southern Utilization Research and Development Div., Agricultural Research Service, USDA, New Orleans, La., was honored recently by the Louisiana chapter of the American Institute of Chemists by presentation with the Honor Scroll of the chapter for 1957. The award, given annually, recognizes outstanding contributions to the advancement of chemistry. Mr. Hopper has been active in ASTM Committees D-13 on Textiles and D-23 on Cellulose and Cellulose Derivatives.

Gerald J. Horvitz, former technical director, has been elected president of New York Testing Laboratories, New York City.

E. J. Jatdzak, until recently testing engineer, Tectum Corp., Newark, Ohio, has accepted a position as research engineer, U. S. Gypsum Co., Gary, Ind.

R. S. Jessup has retired as associate physicist, National Bureau of Standards, Washington, D. C. Dr. Jessup has been active for many years on ASTM Committees D-3 on Gaseous Fuels and D-5 on Coal and Coke.

Warren C. Johnson, for some time with the Department of the Navy, recently as evaluations branch manager, Materials Testing and Evaluation Div., Area Public Works Office, Marianas, has accepted a position with Edwards and Kelcey, engineers and consultants, Newark, N. J., as soils engineer on their Diwaniyah-Nasiriyah highway project for the Development Board of the Government of Iraq. He will be stationed in Bagdad.

William M. Jones, formerly executive director, National Building Granite Quarries Assn., is now associated with Cold Spring Granite Co., of Cold Spring, Minn., with offices in Washington, D. C.

(*Continued on page 120*)

For maximum efficiency in the production of specimens in the metallurgical laboratory the Buehler cabinet type polishing table with companion storage cabinets represents the latest modern development of this type of equipment.

The convenience of this streamlined polishing equipment saves time and encourages the operator to produce the highest quality of polished sample.

Item No. 1511 is a two-unit polishing table with Formica top approximately 60" long x 27" deep by 30" high to table top. Two 12" swing spouts, drain, 8" diameter wash bowl, plumbing and wiring.

Recommended accessories to complete an efficient set up for maximum convenience are: No. 1512 storage cabinet with recessed light and No. 1513 supporting panel for installation above polishing desk. Or, No. 1514 floor model storage cabinet. Both these cabinets can be used together to advantage in most laboratories.

The Formica top and back on the table and cabinet is installed with a smooth Formica edge that eliminates all metal rims that may form pockets for water and dirt. Covers are held in place on the back by magnetic holders. The large 8" wash bowl is a new feature that enables the operator to use both hands in washing specimens.

All metal construction finished in hammer tone grey makes a very attractive appearance. Prompt delivery can be made on these new items.

The Buehler Line of Specimen Preparation Equipment Includes . . . Cut-Off Machines • Specimen Mount Presses • Power Grinders • Emery Paper Grinders • Hand Grinders • Belt Surfacers • Mechanical and Electro Polishers • Polishing Cloths • Polishing Abrasives

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Space permits only a brief description. We welcome your requests for more detailed information.

H-29604

H-29604—Beckman Pocket pH meter, battery operated 6″ x 3″ x 2″ deep. Light weight with unique combination glass and reference electrode which permits holding meter in one hand while taking readings, leaving the other hand free for recording **$99.50**

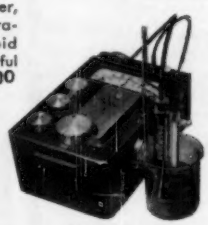
H-28915

H-28915—Beckman Zeromatic pH meter, line operated. Simply push button and take pH or millivolt reading. Drift free, no warm-up time, line voltage compensation, continuous 0-14 pH scale. Outlets provided for recorder, polarizing current, etc. **$295.00**

H-28901

H-29601—Beckman Model N-1 pH meter, battery operated. Range 0-14 pH. Temperature compensator covers 0-100°C. Rapid measurements to 0.1 pH and with careful technique to 0.03 pH **$310.00**

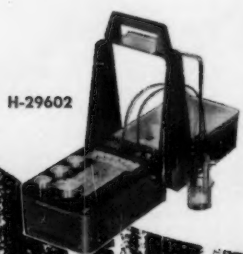
H-28901—Beckman Model GS pH meter, battery operated. For special pH problems and applications requiring extreme precision. This ultra-sensitive instrument is accurate to 0.0025 pH. The meter is a modified model G, which provides 20 times the sensitivity of standard null-meter measuring circuits. Utilizes same electrodes as model G . . **$625.00**



H-29601

H-28900—Beckman Model G pH meter, battery operated. Designed for highest precision and versatility in pH studies, oxidation-reduction potential measurements and titrations with accuracy and reproducibility to ±0.02 pH. **$475.00**

H-28900



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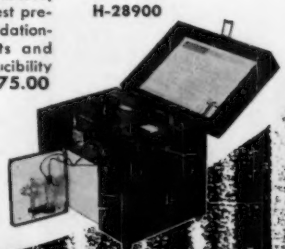
H-29602—Beckman Model N-2 pH. meter. A compact, battery operated meter in carrying case designed especially for portability. Ideal for field use. Range 0-14 pH. Case has compartment for electrodes, beaker and solutions . . . **$360.00**



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FOR FURTHER INFORMATION CIRCLE 964 ON READER SERVICE CARD

(*Continued from page 118*)

Herbert S. Kalish has been appointed section chief, Materials, Metallurgical Laboratories, Olin Mathieson Chemical Corp., New Haven, Conn. He was formerly with Sylvania-Corning Nuclear Corp., Bayside, N. Y. Mr. Kalish is serving on the subcommittee concerned with specifications for nuclear reactor structural materials of ASTM Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys.

William Kowalsky, formerly with Ramseyer & Mills, Inc., is now vice-president, J. R. Miller and Co., New York City.

Gerard K. Lake has been appointed vice-president in charge of product development, Burlington Industrial Fabrics Co., New York City. Mr. Lake has been very active for many years in Committee, D-13 on Textile Materials.

E. E. Laughlin, formerly chief chemist Illinois Industrial Rubber Co., Ladd, Ill., is now manager, Compounding Div., Armstrong Tire and Rubber Co., Natchez, Miss.

Fritz V. Lenel, professor of Mechanical engineering, Rensselaer Polytechnic Institute, Troy, N. Y., and one of twelve 1958 ASTM Award of Merit winners, attended the International Conference on Powder Metallurgy in Reutte, Austria, in June.

Charles S. Lumley, formerly with Burns & Roe of Michigan, Inc., Detroit, is now engaged as consulting engineer in Franklin, Mich.

Russell P. Mahan, formerly with Baird-Atomic, Inc., Cambridge, Mass., is now engaged as a manufacturer's representative. Mr. Mahan resides in South Lincoln, Mass. He has been serving as chairman of the ASTM New England District Council, of which he was formerly secretary.

S. L. Mapes recently retired as chief engineer, Central Railroad of New Jersey. He is succeeded by **B. J. Minetti.**

P. E. McCoy, formerly chief chemist, has been named assistant to vice-president—Technical, American Bitumuls & Asphalt Co., a subsidiary of Standard Oil Co. of California, San Francisco. Mr. McCoy has been active in the work of several of the technical committees of the Society and in the ASTM Northern California District Council. He has been serving as chairman and is a former secretary of the Council.

O. W. McMullan, newly appointed director of research and development of Bower Roller Bearing Div., Federal-Mogul-Bower Bearings, Inc., Detroit, is directing the expansion and centralization of the company's research and development department. He has been chief metallurgist for Bower since he joined the company in 1944.

Donald J. Millar, formerly with Alexander Construction Co., Inc., Chester, Pa., is now materials engineer, Miller-Warden Associates, Absecon, N. J.

Richard F. Miller, assistant to the vice-president, research and technology department of the United States Steel Corp., has been appointed a member of the Boiler and Pressure Vessel Code Main Committee of The American Society of Mechanical Engineers. Mr. Miller has been very active for a number of years in the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals.

Charles S. Mills has been promoted to supervising chemist, Armco Steel Corp., Research Div., Middletown, Ohio. Mr. Mills serves on Committee E-3 on Chemical Analysis of Metals.

G. Mohling, chief metallurgist, research laboratory, Allegheny Ludlum Steel Corp., Brackenridge, Pa., was one of a group of

(*Continued on page 122*)

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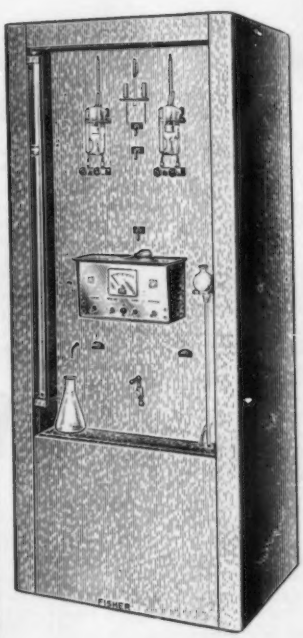
speed and accuracy for vapor pressure measurements



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MODEL III POLAROGRAPH—S-29290—Manual, Indicating. Recommended for use in those routine analyses where only one substance is determined and where the step shape approximates a pure form, characteristic of reversible reactions involving simple ions in fairly substantial concentrations. Also useful in the performance of amperometric titrations and for instructional purposes in educational institutions.

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FOR FURTHER INFORMATION CIRCLE 966 ON READER SERVICE CARD

(*Continued from page 120*)

American steel and iron ore mining executives who recently made a tour of Soviet steel and mining centers.

N. C. Munisteri, formerly with Tagliabue Instruments Div., Weston Electrical Instrument Corp., is now assistant to vice-president, Sales, Weksler Instruments Corp., Freeport, L. I., N. Y.

Don O. Noel has been elected president of Metals Disintegrating Co., Inc., subsidiary of American-Marietta Co.

George L. Otterson has been appointed assistant technical director of Marquette Cement Manufacturing Co., Chicago, Ill. He had been for some time with the U. S. Department of the Army, Materials Office, Chief of Enginers, Washington, D. C.

William A. Reich was appointed manager, engineering section, General Electric Co.'s metallurgical products department in Detroit. He was manager of advance engineering. Mr. Reich was the first chairman of ASTM Committee B-9 on Metal Powders and Metal Powder Products, serving in that capacity from 1944 to 1953.

George Sachs, professor of metallurgical engineering and associate director, Syracuse University Research Institute, Syracuse, N. Y., received an honorary doctor of engineering degree at the May 5, 1958 commencement of the Bergakademie (School of Mines) Clausthal, West Germany.

Jason L. Saunderson, vice-president—Chemical Instrument Engineering, Baird-Atomic, Inc., Cambridge, Mass., was awarded an honorary doctor of science degree by Morningside College, Sioux City, Iowa. Dr. Saunderson is actively engaged in research work at Baird-Atomic in emission spectroscopy, direct reading spectrometry, ultra violet and mass spectrometry. In ASTM he serves on Committee E-2 on Emission Spectroscopy.

Arnold H. Scott, physicist, dielectrics section, Electricity and Electronics Div., National Bureau of Standards, a recipient of a 1958 ASTM Award of Merit, heads the United States delegation to the meeting of Technical Committee 15 on Electrical Insulation and other committees of the International Electrotechnical Commission in Europe in June. In ASTM he was a longtime chairman of Committee D-9 on Electrical Insulating Materials.

Kenneth L. Selby is now vice-president-engineering, National Malleable & Steel Castings Co., Cleveland, Ohio. He was formerly chief engineer, Railway Division.

A. L. Shields retired as manager, materials and process engineering, Westinghouse Electric Corp., Springfield, Mass. Mr. Shields served for many years on the New England District Council.

Earle C. Smith, director of research and chief metallurgist, Republic Steel Corp., Cleveland, Ohio, was among the U. S. delegation of steel and iron mining executives who toured Russia visiting steel mills and ore deposits, as well as the Central Scientific Research Institute of Ferrous Metallurgy in Moscow.

Robert B. Sosman, professor of ceramics, Rutgers University, New Brunswick, N. J., received the Trinks Award, highest honor of the industrial heating industry, for his pioneering research in silica, steel-making refractories, and pyrometry. Dr. Sosman's authoritative book "Properties of Silica" is being revised for republication, and he is author of a second volume "Pyrometry of Solids and Surfaces." Active in many professional and technical groups, Dr. Sosman received an ASTM Award of Merit in 1955, recognizing valued contributions to the work of Committee C-8 on Refractories, of which he was chairman for eight years.

Moyer D. Thomas, senior scientist, air research laboratories, Stanford Research Inst., received the first annual Utah Award of the Salt Lake Section of the American Chemical Society. The award honors individuals who have "made outstanding contributions to the field of chemistry" while within section territory. Dr. Thomas has specialized in techniques

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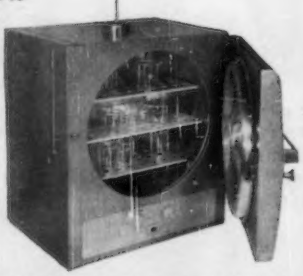

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Knitted—A.S.T.M. D231 and D751
Bonded—A.S.T.M. D1117
Rubber Coated—A.S.T.M. D751
Doped—Fed. Spec. TT-P-141b Meth. 629.1

LEATHER- Grain Cracking—Fed. Spec. KK-L-311a Meth. 2211

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of investigating air and soil pollution and their effects on vegetation. He currently serves as chairman of Subcommittee IV on Instrumentation of ASTM Committee D-22 on Methods of Atmospheric Sampling and Analysis.

Wilmont D. Tidd, formerly plant chemist, Scripto, Inc., Atlanta, Ga., is now technical director, Tesco Chemicals, Inc., in the same city.

Ernest G. Tomlinson, until recently with United Engineers and Constructors, Philadelphia, Pa., is now with Pennsylvania State Department of Forests and Waters, Harrisburg, as hydraulic engineer.

Fred Wehmer has accepted a position as technical director, General Adhesive Co., of Birmingham, Mich., working out of Nashville, Tenn. He had been with Minnesota Mining & Mfg. Co., Adhesives and Coatings Div., St. Paul, Minn.

Charles J. Williams, until recently with Charles J. Williams, Inc., Philadelphia, Pa., is now vice-president and general manager, A. W. Cash Co., Decatur, Ill.

Joseph F. Woodruff has been made supervising spectrochemist, Armco Steel Corp., Middletown, Ohio. Mr. Woodruff is active in ASTM Committee E-2 on Emission Spectroscopy, currently serving as chairman of Subcommittee IX on Ferrous Alloys.

LeRoy L. Wyman, head, chemical metallurgy section, Metallurgy Div., National Bureau of Standards, Washington, D. C., was one of those who recently received Meritorious Service Awards from the U. S. Department of Commerce. Very active in ASTM technical and administrative work for many years, Mr. Wyman was recipient of an ASTM Award of Merit in 1950, recognizing valued contributions in Committee E-4 on Metallography where he has served as chairman since 1938. He served as chairman of the Administrative Committee on Simulated Service Testing for a number of years and currently is a member of the Administrative Committee on Papers and Publications.

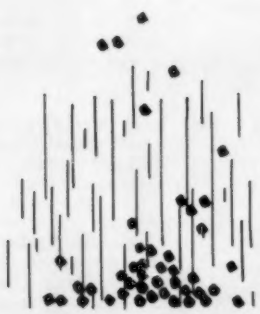
B. C. Yearly, director of applied research, has been named assistant vice-president, National Malleable & Steel Castings Co., Cleveland, Ohio.

DEATHS...

Edward Bartow, emeritus professor of chemistry and chemical engineering, State University of Iowa, Ames died April 12, 1958, at the age of 88. A member of ASTM since 1932, Professor Bartow had served on Committee D-19 on Industrial Water from 1932 to 1954. He had been on the Iowa State faculty since 1920, for 20 years as head of the departments of chemistry and chemical engineering. Affiliated with many societies and organizations, and the author of many technical reports and scientific papers, Dr. Bartow achieved national and international recognition for his investigations in water chemistry. He was president (1934–1938) of the International Union of Pure and Applied Chemistry, representing the United States.

H. C. Berry, retired professor of materials of construction, University of Pennsylvania, Philadelphia, died June 11, 1958. A loyal member of the Society since 1905, Professor Berry had been active on Committee C-7 on Lime, serving as chairman from 1921 to 1932, and representing the committee on Committees E-1 on Methods of Testing, E-5 on Fire Tests of Materials and Construction, and E-8 on Nomenclature and Definitions.

John J. Chapman, research contract director, The Johns Hopkins University, Dielectrics Laboratory, Baltimore, Md., died April 27, 1958. Member of ASTM since 1955, he was active in Committee D-9 on Electrical Insulating Materials. At Johns Hopkins since 1945, and previously for six years with General Electric Co., Dr. Chapman had conducted research in the electrical insulation field, and despite a prolonged illness (he died at the age of 45) he published many papers describing his work on solid dielectric breakdown.



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William H. Eisenman, known throughout the United States and abroad to many thousands as "Bill," died on May 30, 1958 in a La Jolla, Calif. hospital from a heart attack. A founder of the American Society for Metals, known in its early days as the American Society of Steel Treaters, he had been secretary ever since, and built the organization and the National Metal Congress into the influential society it is today. Among the projects on which he had been concentrating the past two years were the Second World Metallurgical Congress (held in Chicago in the fall of 1957) and the broadened activities of ASM which included extensive educational courses, expansion into research work, and a new headquarters building, for which he had donated the land outside Cleveland. A member of ASTM since 1944, he had known many of the national officers and members, and was genuinely interested in the work of the Society. An honorary member of many organizations, Mr. Eisenman had been scheduled to receive an honorary Doctor of Laws degree from Western Reserve University, Cleveland. The degree was conferred posthumously, the citation which had been prepared reading in part: ". . .because you have given your unusual talents and energy to the foundation and development of the professional organizations serving the scientific, technical and educational needs of one of our country's greatest industries; because you have served this University in its pioneering efforts in the field of scientific documentation throughout your deep interest and substantial support. . ."

C. O. Evans, technical staff, Phelps Dodge Copper Products Corp., New York City, died Dec. 8, 1957. He was representative of his company since 1943 on Committee B-5 on Copper and Copper Alloys.

Fred L. Hastings, partner, Murphy & Hastings, civil engineers, Redwood City, Calif., had been a member since 1957.

A. J. Kearfott, assistant department head, General Motors Corp., Research Staff, Detroit, Mich, died May 5, 1958. Member of Society since 1957, and representative of his company on a number of the technical committees for many years, Mr. Kearfott had served on Committee D-11 on Rubber and Rubber-Like Materials since 1941. He also served on the SAE-ASTM Technical Committee on Automotive Rubber, and on Committees D-14 on Adhesives, and D-20 on Plastics.

Joseph M. Kelly, Jr., Armour Research Foundation, Chicago, Ill., died Feb. 20, 1958. Dr. Kelly had represented the Foundation on Committee A-6 on Magnetic Properties since August 1957.

Vsevolod N. Krivobok, supervisor of the stainless steel and heat-resistant alloy section, Development and Research Div., The International Nickel Co., Inc., New York City, died May 17, 1958. A well-known authority on stainless steels, Dr. Krivobok had been with International Nickel since 1944; previously he had been chief metallurgist with Lockheed Aircraft Corp., Burbank, Calif., and in the 1930's he had been associate director of research for Allegheny Ludlum Steel Corp., Brackenridge, Pa. For many years he also was a member of the faculty and professor of metallurgy at Carnegie Institute of Technology, and a member of the Metallurgical Research Bureau of the Institute. In ASTM, Dr. Krivobok had served for many years on Committee A-10 on Iron-Chromium, Iron-Chromium-Nickel and Related Alloys, representing International Nickel, and in earlier years as representative of Allegheny Ludlum. He also was a member of the General Research and Low Temperature Panels of the ASTM-ASME Joint Committee on Effect of Temperature on the Properties of Metals.

Joseph J. Markey, sales engineer, The Haller Engineering Associates, Inc., Boston, Mass., died Jan. 8, 1958. He had been a member since 1943.

Rolla E. Pollard, Metallurgist, National Bureau of Standards, Washington, D. C., died May 22, 1958. He had been a member since 1949 and representative of the Bureau on Committee B-9 on Metal Powders and Metal Powder Products.

Stewart E. Printz, retired engineer of tests, Lehigh Valley Railroad, Sayre, Pa., died in West Palm Beach, Fla., March 17, 1958. Mr. Printz, who retired in 1954, had been with the Railroad 44 years. He had represented the Railroad in the Society for the entire period, serving on Committees A-1 on Steel, A-2 on Wrought Iron, and A-3 on Cast Iron.

Leon Sternberg, production chemist, Fedders-Quigan Corp., Maspeth, L. I., N. Y., died Feb. 20, 1958. He had been a member since 1953.

Raymond L. Thatcher, manager, quality control division, E. H. Squibb and Sons, Olin Mathieson Chemical Corp., New Brunswick, N. J., died May 18, 1957. He had been a member since 1951.

Thomas G. Stitt, retired chief inspecting engineer, Pittsburgh Steel Co., Allenport, Pa., died May 24, 1958. An extremely loyal and hard-working ASTM member, he was chairman for many years of Subcommittee IX of Committee A-1 on Steel which is concerned with steel pipe and tubing. Mr. Stitt received an ASTM Award of Merit in 1950 for his outstanding service in Committee A-1. During World War II, he headed the National Emergency Steel Committee. He was chairman for many years of the American Iron and Steel Institute Tubular Products Committee. During his ASTM service, the number of specifications for tubular products of all kinds increased greatly, and have been of widespread service wherever pipe and tubing are used.

(*Continued from page 97*)

Ten Years of Building Research 1947–1957

Division of Building Research, National Research Council of Canada, Ottawa, Canada, $1.

THE Division of Building Research of the National Research Council of Canada has issued an interesting and very well prepared booklet recording its history and accomplishments since 1947.

The Division of Building Research was established in recognition of the general need for building research with specific attention being given to the revision of the National Building Code and for technical support to the national housing agency, Central Mortgage and Housing Corp.

Chapters in the publication review the work of the several sections, such as design, materials, physics, services, climate, snow and ice, and soils and foundations. A new fire laboratory is described in a chapter on fire research. Much additional information is included on staff organization, publications, research projects, and other associated groups and activities.

OTS Research Reports

THESE reports, recently made available to the public, can be obtained from the Office of Technical Services, U. S. Department of Commerce, Washington 25, D. C. Order by number.

Coiled Stainless Steel Tubing: Part 1—Test Results. PB 131719, $2.75.

Coiled Stainless Steel Tubing: Part 2—Design Manual. PB 131720, $1.25.

Effects of Temperature–Time–Stress Histories on the Mechanical Properties of Aircraft Structural Metallic Materials: Part 1—Temperatures–Time Studies for 2024-T3 and 7075-T6 Alclad Sheet. PB 131520, $5.50.

Research on a Method for Determining Boron in Low-Boron Steels. PB 131374, 50 cents.

Magnesium Alloys with High Melting Point Additions. PB 131198, $5.

Investigation of the Effects of Incongruous Elements and the Inter-action Effects of These Elements on High Temperature Strength of Fe-Co-Ni-Cr Alloys. PB 131614, $2.50.

A Study of the Metallurgical Properties that are Necessary for Satisfactory Bearing Performance and the Development of Improved Bearing Alloys for Service up to 1000 F. PB 131609, $2.

Determination of the Tensile, Compressive, and Bearing Properties of Ferrous and Nonferrous Structural Sheet Materials at Elevated Temperatures. PB 131595, $2.50.

Alumina–Base Cermets, Part 4. 50 cents.

Summary of Development and Evaluation of Insulating Type Refractory Coatings. PB 121759, $3.75.

Ceramic Reinforced Alloys and Plated Cermets. PB 131188, $1.25.

Factors Controlling Resistance to Deformation and Mechanical Failure in Polycrystalline (Glass-Free) Ceramics. PB 131623, $2.

Preliminary Microscopic Studies of Cermets at High Temperatures. PB 131470, $1.25.

(*Continued on page 130*)

NEWS NOTES ON
Laboratory Supplies and Testing Equipment

Note—This information is based on literature and statements from apparatus manufacturers and laboratory supply houses. The Society is not responsible for statements advanced in this publication.

LABORATORY ITEMS

Lab Tank—A 10-gal polyethylene tank, ideal for laboratory, metal cleaning, or other acid service where corrosion is a problem, has just been introduced.
American Agile Corp. 1622

Gradient Furnace—Has 25 temperature zones which can hold 25 different temperatures on a specimen during testing. Previously, a specimen had to be heated during 25 individual tests to get the same results.
Arcweld Mfg. Co. 1623

Transistor Test Set—Model T-340 provides four basic parameters, Beta, Icbo, Ico and Ieo, of both pnp and npn transistors—are accurately measured with the transistor plugged into a common emitter circuit. A function selector establishes precisely controlled test conditions with a minimum of individual adjustment. Results are read directly from a meter; no calculations are required.
Baird-Atomic, Inc. 1624

Scaler—A new glow tube scaler for geiger counting is now offered. The B-A Model 123 GM Scaler has an all glow tube five-digit capacity with no mechanical register required.
Baird-Atomic, Inc. 1625

Transistor Tester—A new general purpose transistor test set, the B-A Model KP-2, is a versatile precision instrument for analyzing transistors at frequencies from 100 cps to 200 kc, valuable and dependable for both laboratory and production work.
Baird-Atomic, Inc. 1626

Color-Analyzer—New color analysis instrument which permits extremely accurate readings in per cent reflectance of paints, textiles, plastics, inks, dyes, glass, tile and a variety of other products has been announced. This new instrument consisting of a Spectronic "20" spectrophotometer and a reflectance attachment, provides easy, low cost color analysis.
Bausch & Lomb Optical Co. 1627

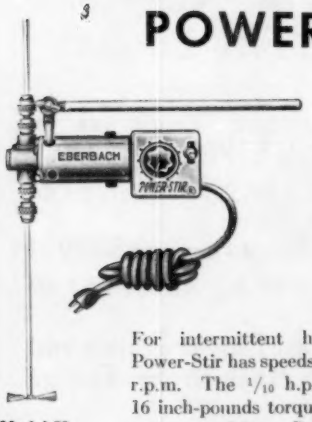
Electrobalance—A twist of the range selector switch sets the balance to a range as low as 0–1 mg, or as high as 0–100 mg. Operation is fast and easy, with one-knob control and one dial for weight reading.
Cahn Instrument Co. 1628

Vacuum gage—A new, single-station, battery-operated thermocouple vacuum gage designated Type GTC-110, is now available. Powered by a 1.5-size "D" flashlight battery, contained in the gage housing, the GTC-110 covers the range from 0 to 1000 microns Hg on one nonlinear scale, with 5 microns the smallest indicated marking.
Consolidated Electrodynamics Corp. 1629

Galvanometers—Six new high-temperature galvanometers known as Types 7-350, 7-352, 7-354, 7-355, 7-381, and 7-382, have been designed for use with Consolidated's Type 5-122 Recording Oscillograph, developed for high-altitude, high-temperature flight testing.
Consolidated Electrodynamics Corp. 1630

NEW HIGH TORQUE • VARIABLE SPEED

POWER STIR



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- Fits Narrow Space
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- 3-Wire Cord is Standard
- Hinged Support Rod

For intermittent heavy duty, the Power-Stir has speeds from 100 to 1000 r.p.m. The 1/10 h.p. motor develops 16 inch-pounds torque thru quiet 20-1 worm gear drive. Power-Stir is hinged on a 1/2" x 11" nickel-plated rod and positioned by a large wing nut. Running current, full load is .8 ampere-115 volt, AC.

No. 77-836 Power-Stir $32.50
No. 77-837 1/4" rod with 2" dia. blade 18" length . . . $2.50

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Hardness Tester—Surdd hardness tester for measuring the hardness of fats, waxes, and related materials has been announced.
Custom Scientific Instruments, Inc. 1631

Audio Delay Lines—A new series of balanced delay lines is being introduced. These precision delay lines are available in various delay times up to 8 milliseconds; longer delays are obtainable by cascading units.
Components Div. Epsco, Inc. 1632

Magnetic Metal Inspection—Ferroflux, a low-cost, portable magnetic inspection device which effectively detects surface and sub-surface defects in ferromagnetic material, is announced.
Ferro Machine & Tool Co. 1633

Lab Sink—The new large sink unit in the line of steel lab furniture is 5 ft wide, furnishing extra sink-top and cupboard space to forestall the bottlenecks of conventional 4-ft sinks.
Fisher Scientific Co. 1634

Compression Tester—New Model QC-100-SLD compression and flexure tester is designed especially for plant and jobsite use. Equipped with 12-in. diam, spring mounted, high and low pressure gages and two stage manual pump.
Forney's, Inc. 1635

Ellipsometer—New optical measuring instrument recently developed, is designed for the investigation and measurement of thin films by the use of elliptically polarized light.
Gaertner Scientific Corp. 1636

Capacitance Bridge—Type P-582 capacitance bridge meets the essential requirements of Specification MIL-T-4778. It is a self-contained bridge system which includes a 400-cycle oscillator and a sensitive null indicator.
General Radio Co. 1637

Thermometer—A new thermometer known as Model No. 2900 is made of heavy metal, with black figures $^{7}/_{16}$ in. high, on a white background.
General Scientific Equipment Co. 1638

Segmental Recorder—The new Model 156 segmental recorder is designed to give visual "on-the-spot" data plotting to supplement nonindicating scanning systems.
Gilmore Industries, Inc. 1639

Lubricant Tester—A new friction and wear testing instrument, the Hohman A-6 solid lubricant tester can be used for the simulation of most types or combinations of wear, heat, and atmospheric conditions that are usually encountered by solid film lubricants.
Hohman Plating & Mfg., Inc. 1640

DC Instrument—The Model 610 electrometer makes virtually all d-c measurements required in laboratory and production tests. The single unit measures volts, ohms, and amps.
Keithley Instruments, Inc. 1641

Furnace—Development of a new box-type furnace with 3000 F refractory incorporates several distinctive construction features typified by long-lasting Crystolon heating elements and a unique new transformer.
Laboratory Equipment Corp. 1642

Ultrasonic—The new, Series 200, Narda SonBlasters, laboratory size, ultrasonic cleaning, and chemical process investigation unit has been introduced.
Narda Ultrasonics Corp. 1643

Electrometer—The Dynacon, a dynamic condenser electrometer, is a new radioactivity measuring system particularly designed for soft beta emitters such as tritium, carbon-14, sulfur-35, etc.
Nuclear-Chicago Corp. 1644

Wire Sparker—A new model of high-voltage, d-c sparker which permits nondestructive fault detection at wire speeds of 4000 fpm with an electrode of zero-length, is now available.
Peschel Electronics, Inc. 1645

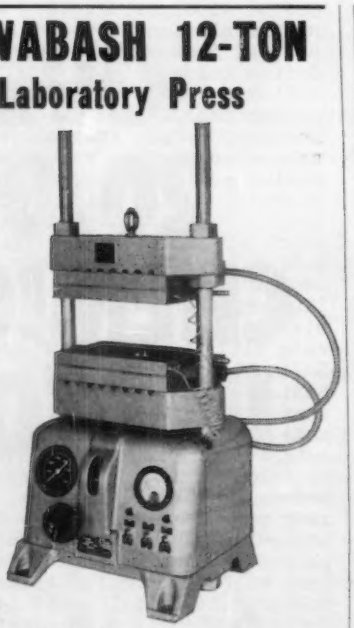
Nikor Film—The problem of developing the long strips of 70 mm X-ray film used for radiographing circumferential welds in large pressure vessels can be easily solved by the Nikor Film Processing Equipment. It will handle any length of film up to 100 ft.
Picker X-ray Corp. 1646

Aging Block—The Comet Model 600 aging block is a new precision testing device for determining the aging characteristics of natural rubber, synthetic and light polymers, silicones, plastics, and similar materials under closely controlled temperatures ranging from 100 to 600 F. Equipped with 13 individual test tube compartments, the Comet eliminates errors due to migration and contamination of materials.
Product Packaging Engineering 1647

This new WABASH 12-TON
Hydraulic Laboratory Press

Pays Its Way In Plastics Molding Plants

The new Model 1210-N, 12-ton press, is feature packed: Streamlined cabinet—high visibility gauges. Controls away from heat zone. Closely controlled temperature, 90°F. to 600°F. Silent mercury relays—no chattering. Fast action hydraulic ram. Element connections shielded and ventilated. Cast platen supports vented for cooling. Blanchard ground 7" x 10" platens. Hard chrome rustproof columns. Easily adjustable daylight. Water cooled platens also available.



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FOR FURTHER INFORMATION CIRCLE 972 ON READER SERVICE CARD

Do you have these New ASTM Books?

Elevated Temperature Properties of Chromium Steels STP228
$4.25, members $3.40

Brittle Fracture of Rotor Forgings STP231
$2.00, members $1.60

Tentative Guide for Fatigue Testing and the Statistical Analysis of Fatigue Data STP91A
$3.75, members $3.00

Conference Papers on Soils for Engineering Purposes STP232
$9.00, members $7.20

American Society for Testing Materials
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CATALOGS & LITERATURE

Grinding Machine—A new 2-page bulletin, *No. 2297*, describes the laboratory grinder, an instrument designed to prepare laboratory test specimens of flexible materials, such as leather, rubber, linoleum, etc.
American Instrument Co., Inc. 2403

pH Meters—Two new Application Data sheets describe use of Beckman pH Meters in titration work.
Beckman/Scientific Instruments Div. 2404

Chromatographic Alumina—New information sheet contains information and prices on activated aluminas in two standard sieve sizes: 100 to 200, and minus 200.
BIO-RAD Laboratories 2405

Chromatography—*Bulletin No. 837*, describing Model K-5 Kromo Tog, offers an advanced new research instrument for analysis by gas and vapor chromatography.
Burrell Corp. 2406

Flame Photometer—*Bulletin B242* describes the Coleman Model 21 Flame Photometer—designed for the rapid determination of sodium, potassium, and calcium.
Coleman Instruments, Inc. 2407

Nephelometers—Nephelometers used to measure and control the clarity of beverages and other liquids, pharmaceuticals, industrial fluids, contaminants in water, and bacterial growth rates are described in *Bulletin B246*.
Coleman Instrument, Inc. 2408

Optics—A 16-page booklet in color describes optical instruments.
Consolidated Electrodynamics 2409

Vapor Pressure—*Bulletin FS-272* describes the Fisher Micro Vapor Pressure Apparatus, a new high-speed, high-accuracy technique for measuring the vapor pressure of volatile liquids, and the new instrument developed for the technique.
Fisher Scientific Co. 2410

Transformer—The new, fully illustrated, 48-page catalog *No. 581* is now available. Included and described are complete lines of audio transformers, discriminators, filters, high-Q reactors, magnetic amplifiers, power components, pulse transformers, and ultrasonic components.
Freed Transformer Co., Inc. 2411

Testing Screen—Folder contains data sheets on sieves, testing screens, timers, etc.
The Gilson Screen Co.

Testing Equipment—*Bulletin No. 24* describes testing equipment suitable for many ASTM tests.
Humboldt Mfg. Co. 2413

Catalog—Sixteen-page Apparatus Review No. 8 features new high-speed centrifugal chromatograph in full-color, four-page section. Apparatus items described include a new model five-in-one control with U-type grounding plug, the Tempunit for water baths, thermistor Tele-thermometers, etc.
Arthur S. LaPine & Co. 2414

Mueller Bridges—A new 6-page *Data Sheet E-33(3)* describing the Type G-1 and G-2 Mueller Bridges is now available.
Leeds & Northrup Co. 2415

Bellows Flow Meter—A new 20-page catalog *C22-1* covers the features, specifications, and applications of the Honeywell Bellows Meter. Two basic models are described—one for flow, and liquid level in open tanks, the other for liquid level in closed tanks under pressure or vacuum.
Minneapolis-Honeywell Regulator Co. 2416

Calibrating Machine—A universal calibrating machine which facilitates the calibration of load cells is described in a 4-page bulletin, *No. 158*.
Morehouse Machine Co. 2417

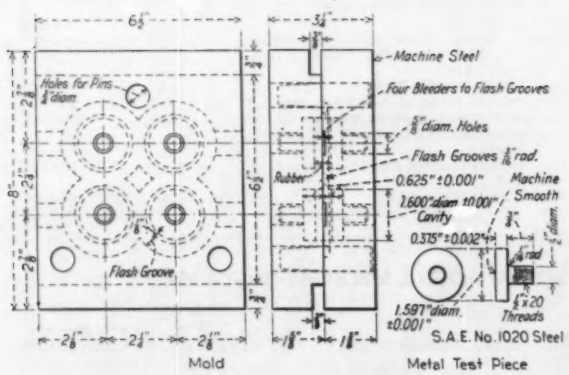
Detection Instruments—Three of the newest radiation detection instruments are featured in the latest issue of "The NMC Fallout," the NMC house organ.
Nuclear Measurements Corp. 2418

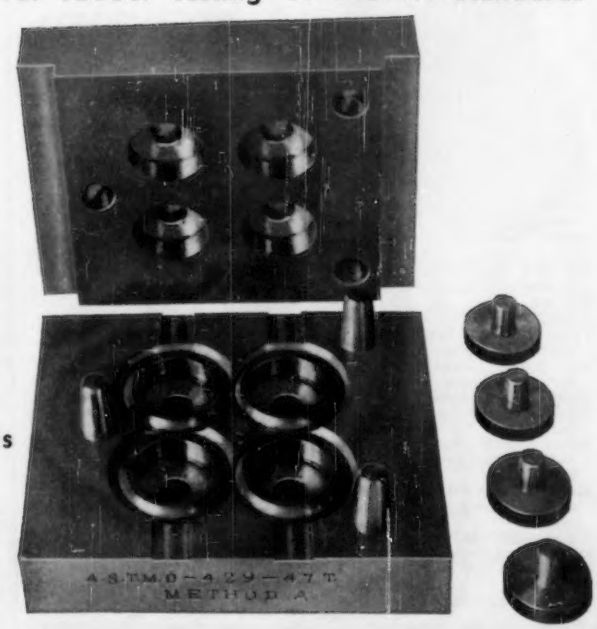
Proportional Counters—Four-page *Bulletin PC-58* gives specifications on the two proportional counter models for precision measurement of alpha and beta-gamma activity.
Nuclear Measurements Corp. 2419

(*Continued on page 130*)

HOGGSON

TOOLS, MOLDS AND DIES
for rubber testing to ASTM standards





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D429-47T. METHOD A

This is but one of many Hoggson molds for making standard test samples for not only adhesion, but also abrasion, flexing, compression and rebound. Also hand-forged dies for cutting various test samples from sheet rubber, plastic, or other synthetics. Describe your problem and we will furnish details of the piece required.

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FOR FURTHER INFORMATION CIRCLE 973 ON READER SERVICE CARD

Federal Government Standards Changes

THE General Services Administration of the Federal Supply Service is charged with the responsibility for establishing specifications to be used by the Federal Government for procurement of materials and supplies. The GSA issues an annual Report of Initiation of Federal Specifications and Federal Standards Projects, and monthly supplements.

The items listed below appeared in Supplements Nos. 1 and 2 for the months of April and May 1958.

INITIATIONS

Title	Type of Action	Symbol or Number	FSC Code	FSSC Class	Assigned Agency & Preparing Activity
Aluminum Alloy, 14S: Bars, Rods and Shapes-Extruded	Rev.	QQ-A-261a	9530	..	DOD-USAF
Aluminum Alloy 14S Bars, Rods, Shapes, and Wire (Rolled or Drawn)	Rev.	QQ-A-266a	9530	..	DOD-USAF
Aluminum Alloy 24S; Bars, Rods, and Shapes-Extruded	Rev.	QQ-A-267a	9530	..	DOD-USAF
Aluminum Alloy, 24S: Bars, Rods, and Wire (Rolled or Drawn)	Rev.	QQ-A-268a	9525 9530	..	DOD-USAF
Aluminum Alloy 75S; Bars, Rods, and Shapes-Extruded	Rev.	QQ-A-277a	9530	..	DOD-USAF
Aluminum Alloy 3003; Bars, Rods, and Shapes-Extruded	Rev.	QQ-A-357a	9540 9530	..	DOD-USAF
Aluminum Alloy 52S; Bars, Rods, and Wire (Rolled or Drawn)	Rev.	QQ-A-315b	9530	..	DOD-USAF
Aluminum Alloy 75S; Bars, Rods, Shapes, and Wire (Rolled or Drawn)	Rev.	QQ-A-282a	9530	..	DOD-USAF
Aluminum Alloy 1100; Bars, Rods, and Wire (Rolled or Drawn)	Rev.	QQ-A-411d	9525	..	DOD-USAF
Aluminum Alloy 3003; Bars, Rods, and Wire (Rolled or Drawn)	Rev.	QQ-A-356d	9525	..	DOD-USAF
Aluminum Alloy 6061; Bars, Rods, Shapes, and Wire (Rolled or Drawn)	Rev.	QQ-A-325b	9525	..	DOD-USAF
Artificial Leather, Upholstery (Synthetic Resin-Coated Cloth)	Rev.	CCC-A-700a	8305	83	DOD-Army-QMC
Brazing Alloys, Copper Zinc, Filler Metal	Rev.	QQ-B-650a	3432	..	DOD-Navy-Ships
Cable, Telephone	New	J-C-96	6625	18	DOD-Army-SigC
Chloroform, Technical	Rev.	O-C-291a	6810	..	DOD-Army-CmlC
Cloth, Cotton, Muslin	New New	CCC-C-446a & CCC-C-00446 (GSA-FSS)	8305	83	GSA-FSS
Dishwashing, Compound, Machine	Rev.	P-D-425a	7930	51	DOD-Army-QMC
Gasoline, Automotive	Rev.	VV-G-76	..	..	DOD-Army-Ord
Glycerin (Glycerol)	Rev.	O-G-491b	6810	..	DOD-Army-CmlC
Lubricants, Liquid Fuels, and Related Products	Chg. Notice 3	..	..	..	DOD-Army-Ord
Pipe and Fittings, Malleable Iron, Wrought Iron, and Steel (Screwed) 150 pound	Rev.	WW-P-521d	..	..	DOD
Roof Coating: Asphalt, Brushing-Consistency	New	SS-R-00451a (GSA-FSS)	..	..	GSA-FSS
Sheathing Board, Gypsum	Am. 2	SS-S-276	..	..	GSA-FSS
Sodium Bicarbonate, Technical Grade	Rev.	O-S-576c	6810	..	DOD-Army-CmlC
Sodium Carbonate, Anhydrous, Technical (Soda Ash)	Rev.	O-S-571e	6810	..	DOD-Army-CmlC
Sodium Hydroxide, Technical, for Cleaning Purposes	Rev.	P-S-631b	6810	51	DOD-Army-CmlC
Sodium Metasilicate	Rev.	O-S-604a	6810	51	DOD-Army-CmlC
Sodium Silicate, Liquid	Rev.	O-S-605b	6810	..	DOD-Army-CmlC
Tile, Floor, Vinyl Plastic	Rev.	L-T-00752 (COM-NBS)	..	..	COM-NBS
Tile, Floor, Vinyl-Asbestos	Rev.	L-T-00745 (COM-NBS)	..	..	COM-NBS
Tube, Aluminum Alloy; Round, Square, Rectangular, and Other Shapes, Seamless, Drawn	Rev.	WW-T-788c	4710	..	DOD-USAF
Tube, Aluminum Alloy 1100; Round, Square, Rectangular, and Other Shapes, Seamless, Drawn	Rev.	WW-T-783c	4710	..	DOD-USAF
Tube, Aluminum Alloy 2024; Round, Square, Rectangular, and Other Shapes, Seamless, Drawn	Rev.	WW-T-785b	4710	..	DOD-USAF
Tube, Aluminum Alloy 5052; Round, Square, Rectangular, and Other Shapes, Seamless, Drawn	Rev.	WW-T-787b	4710	..	DOD-USAF
Tube, Aluminum Alloy 6061; Round, Square, Rectangular, and Other Shapes, Seamless, Drawn	Rev.	WW-T-789b	4710	..	DOD-USAF
Zinc Alloy Sheets and Strips	New	QQ-Z-00100 (GSA-FSS)	..	..	GSA-FSS

PROMULGATIONS

Title	Type of Action	Symbol or Number
Aluminum Alloy, Plate and Sheet, Alclad 2024 (superseding-FS QQ-A-362a)	Rev.	QQ-A-362b
Aluminum Alloy, Plate and Sheet 3003, (superseding-FS QQ-A-359c)	Rev.	QQ-A-359d
Aluminum Alloy, Plate and Sheet 6061 (superseding-FS QQ-A-327a)	Rev.	QQ-A-327b
Aluminum Alloy, Plate and Sheet 7075 (superseding-FS QQ-A-283)	Rev.	QQ-A-283a
Aluminum Alloy, Plates and Sheets, Alclad 2014 (R301, Clad 14S)	Am.	QQ-A-255a
Benzene (Benzol), Technical (superseding IFS VV-B-00231b (GSA-FSS) and FS VV-B-231a)	Rev.	VV-B-231c
Cable, Power, Electrical (Flexible Cord and Fixture Wire)	Am.	J-C-90a
Cloth, Cotton, Jean, (Bleached) (superseding Fed. Spec. CCC-J-191)	New	CCC-C-444
Cloth, Jute (Or Kenaf), (superseding FS CCC-B-811)	New	CCC-C-467
Excelsior, Wood, Fabricated Pads, and Bulk Form (superseding IFS PPP-E-00911 (COM-BDSA) & FS NN-E-911a)	New	PPP-E-911a
Graduates, Glass; Pharmaceutical and Commercial (superseding FS-DD-G-666)	Rev.	DD-G-666a
Paint, Exterior, Fire Retardant, White, and Light Tints (superseding TT-P-0034 ArmyCE)	New	TT-P-34a
Paint, Traffic, Exterior, White, and Yellow	Am.	TT-P-115a
Soap, Automobile and Floor, Liquid and Paste (superseding IFS P-S-00598c (GSA-FSS) & FS-P-S-509b)	New	P-S-560
Soap, Built, High-Titer, Powdered (superseding P-S-00563a (GSA-FSS) and P-S-563)	Rev.	P-S-563b
Soap, Laundry, Bar	Am. 1	P-S-591e
Sodium Borate, Decahydrate, Photographic $Na_2B_4O_7.10H_2O$ (superseding O-S-00661a (GSA-FFS) and O-S-661)	Rev.	O-S-661b
Sour, Laundry, Fluoride Type	Am. 1	P-S-683
Stain Remover, Tableware, Oxygen-Releasing Type	New	P-S-730
Sweeping Compound Absorbent Material, Oil and Water (superseding IFS P-S-00865 (GSA-FSS) and FS P-A-91)	New	P-S-865a
Tape, Pressure-Sensitive Adhesive, Paper, Water Resistant	Am. 1	PPP-T-76
Thimble, Extraction	New	GG-T-380

INTERIM FEDERAL SPECIFICATIONS ISSUED

Title	Type of Action	Symbol or Number
Bags, Shipping, Cushioned	New	PPP-B-0030a (GSA-FSS)
Brazing, Alloys	New	QQ-B-00655a (Army-Ord)
Flooring, Hardwood Blocks, Solid Unit, and Laminated	New	NN-F-00476a (GSA-FSS)
Funnels, Glass; Fluted or Ribbed	New	DD-F00796a GSA-FSS)
Funnels, Glass; Smooth (Chemical)	New	DD-F-00806a (GSA-FSS)
Glazing Compound, Sash (Metal) for Face and Channel Glazing	New	TT-G-00410 (GSA-FSS)
Liner Material, Greaseproof, for spirally wound fiber Containers	New	PPP-L-00440 (GSA-FSS)
Paper, Bond and Writing, White and Colored	New	UU-P-00121g (Navy-S&A)
Paper; Index (Bristol)	New	UU-P-00-58d (GSA-FSS)
Paper, Toilet Tissue	Rev.	UU-P-00556e (GSA-FSS)
Pitch, Coal Tar (for) Coating Bituminous Pavements	Rev.	R-P-00355a (GSA-FSS)
Printing and Stationery Paper, Packaging for Domestic and Overseas Shipment	New	PPP-P-0025a
Tape, Gummed, Paper, Reinforced	New	PPP-T-0045 (GSA-FSS)
Towels, Terry Cloth	New	DDD-T-00551c (GSA-FSS)

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Catalogs & Literature

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Pulse Analyzer—Eight-page pamphlet lists complete specifications and operating characteristics of its improved 256-Channel Pulse Height Analyzer, Model 20609.
Radiation Counter Labs., Inc. 2420

Catalog—The May, 1958 Issue of LABORATORY is a 16-page booklet featuring chromatographic equipment with emphasis on the new low-cost Chromatocab, the new improved fraction collector with a totalizer-multiplier attachment which doubles the count capacity up to 800.
Schaar & Co. 2421

Catalog—A new edition of "What's New for the Laboratory," 33rd in the series, is announced. Items illustrated and described in this new 16-page issue include the new "Precision" Hi-Speed Centrifugal Chromatograph, Polypropylene Wares and "B&L" Spectronic Color Analyzer.
Scientific Glass Apparatus Co., Inc. 2422

Gauge Saver—Automatic shut-off valves for overload protection of gages and instruments in hydraulic and pneumatic systems are listed in new bulletin. Six models offer pressure ranges from 10 to 10,000 psi.
Sprague Engineering Corp. 2423

Variable Transformers—Powerstat variable transformers which deliver a continuously adjustable voltage from a-c power lines are now available in functionally designed dust-tight enclosures featuring wide flexibility in application and mounting position.
Superior Electric Co. 2424

Feeder Machines—A new catalog of "vibra-flow" dry feeder machines which provide accurate feeding of dry chemical reagents for water filtration, sewage disposal, and other industrial processes is announced.
Syntron Company 2425

Catalog—A completely indexed 128-page catalog and price list describes the newest developments in testing equipment related to soils, concrete, and asphalts.
TESTlab Corp. 2426

Beta-Ray Spectrometer—The Siegbahn-Slatis Beta-Ray Spectrometer, CE-9, marketed in the U. S. for LKB-Produckter of Stockholm, is one of the fundamental tools in nuclear spectroscopy. It is used to measure the energy distribution of beta particles.
Tracerlab, Inc. 2427

Laboratory Items

(*Continued from page 126*)

Chart Viewer—A new oscillographic recording chart viewer provides variable chart drive speeds from 15 in. per min. to 100 ft. per min., and accepts charts up to 16 in. wide and 200 ft long.
Sanborn Co., Industrial Div. 1648

Thermometer—The Shawmeter, a new type instrument which will measure the temperature of any solid, liquid, or luminous flame in the 1500 to 4000 F range without need for making emissivity corrections, has been developed.
Shaw Instrument Corp. 1649

Portable Concrete Tester—A new portable concrete testing machine has been announced. This tester makes possible rapid on-the-job-testing of concrete cylinders up to a total applied load of 200,000 lb.
Soiltest, Inc. 1650

Portable Hardness Tester—The Penetrascope which performs a Diamond Pyramid Hardness test is manufactured in England. The design, procedure of using the tester, and results obtained all conform to the ASTM Standard E 92 – 57.
Steel City Testing Machines, Inc. 1651

Solar Furnace—A new and fully automatic solar furnace is now available to research laboratories and scientific and industrial testing companies.
Thermal Dynamic Products, Inc. Div. of Waltham Precision Instr. Co. 1652

Thermocouple Assemblies—A new, expanded line of industrial thermocouple assemblies consist of standard wire-type and "Ceramo" thermocouples, connection heads, thermowells, fittings, and mounting attachments.
Thermo Electric Co., Inc. 1653

Thermometer Controller—Type 500 units are provided with a new-style, wide-scale pyrometer having white characters on a black background. The easy-to-read double scale is accurately calibrated to 2000 F and 1000 C.
Thermo Electric Mfg. Co. 1654

Melting Point Apparatus—The Thomas-Hoover "Uni-Melt" Capillary Melting Point Apparatus provides the operator with a high degree of reproducibility of results with the accuracy required by official U. S. P. Methods.
Arthur H. Thomas Co. 1655

Carbon Counter—A newly developed detection unit for the CE-14 Carbon Counter which provides for analysis of a standard 2-in. diam sample is announced. The average background registered on the unit is less than 1.5 cpm.
Tracerlab, Inc. 1656

Coating-Thickness Tests—A new accessory permits nondestructive measurements of most coatings and films on the inside diameters of pipes, bores in castings, etc., down to $^1/_2$ in. inside diameter.
Unit Process Assemblies, Inc. 1657

Vacuum Controller—A new automatic controller actuated by a thermocouple vacuum gage for electrically controlling vacuum or process equipment is now available.
Veeco Vacuum Corp. 1658

(*Continued from page 124*)

Metal-Cyclopentadienyl High-Temperature Lubricants and Related Materials: Part 1—Synthesis and Properties of Alkyl, Alkaryl, and Metalated Derivatives of Ferrocene. PB 131701, $1.25.

Part 2—A Synthesis and Properties of Aryl, Benzyl, and Silyl Derivatives of Ferrocene, B. Preliminary Studies on the Effect of Tetrahydrofuran on the Lithiation of Ferrocene PB 131714, 75 cents.

Part 3, Mixed Symmetrical Tetraalkylsilanes PB 131424, 50 cents.

Theoretical and Experimental Studies of Liquid Viscosity: Part 2—Historical Background. PB 131407, $1.50.

High Temperature Hydraulic Fluid Development Status and Engineering Data. PB 131512, $1.25.

Polymerization Through Coordination (Plastic materials that are stable from −80 to 800 C). PB 131517, $1.50.

Development of Fluoro-Silicone Elastomers, Part 3. PB 131425, $1.75.

Development of Thermally Stable Silicon Containing Resins, Part 2. PB 131715, $2.00.

Coordination Polymers, Part 1. PB 121867, $2.75. Part 2. PB 131649, $2.00.

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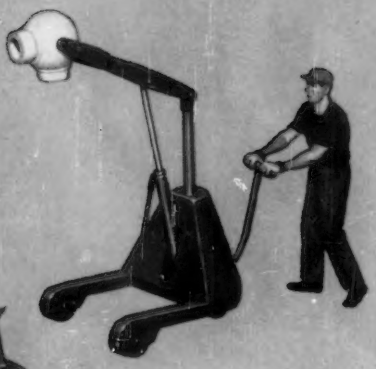

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6"	5 min
7"	33 min
8"	1.4 hrs

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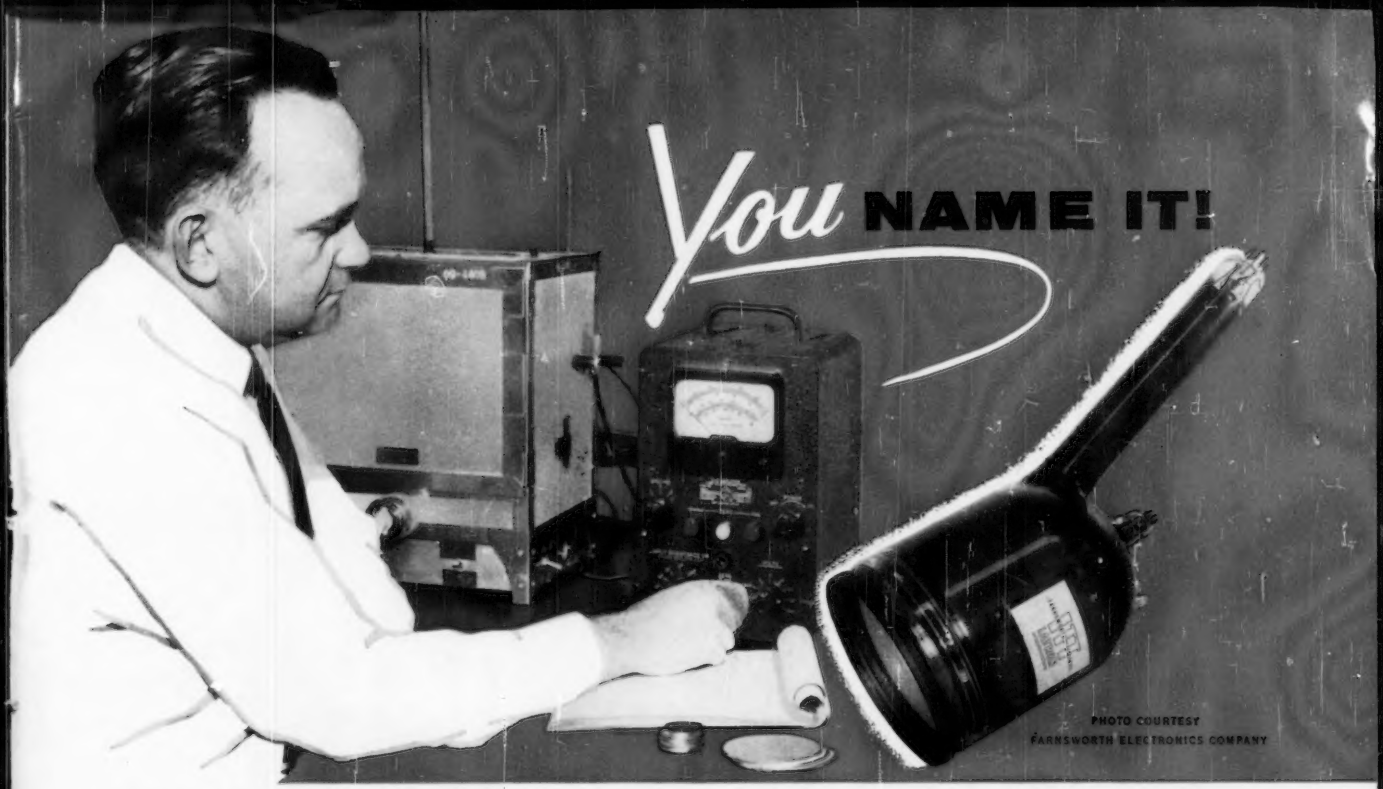

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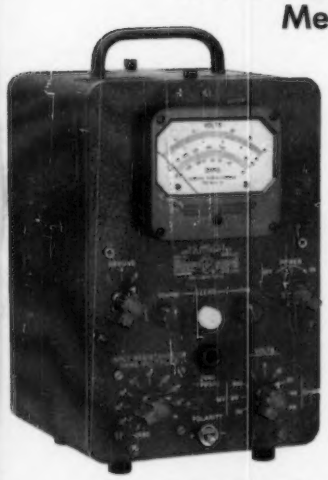

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Drift: Less than 2 mv per hour after one-hour warmup.

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